…uary 1968

RECLAMATION ERA

February 1968 • Vol. 54, No. 1

RECLAMATION ERA

Gordon J. Forsyth, Editor

CONTENTS

COVER PHOTO. More such cattle views as this and better steaks for dinner tables will result from the water control systems of the Oahe Irrigation Project, S. Dak.
(*Photo by Lyle C. Axthelm*)
For other values of dams see Commissioner Dominy's article: "Dams Save and Serve," on next page.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C., 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 30 cents (single copy). Subscription price: $1.00 per year (25 cents additional for foreign mailing).

Commissioner's Page

Better the Bulwark

It is an operation as old as man: Put a dam across a stream, cut the bank, and water flows on thirsty land.

As time passed, dams came far from the first primitive innovations. The construction of dams evolved into a science which has brought many of the great rivers of the world under control. In a large number of arid and semi-arid regions now flourishing, dams are the bulwark of a better life.

Since coming into being 66 years ago, the Bureau of Reclamation has built more than 200 storage dams in the West. These structures bring not only irrigation benefits, but also provide flood control, power generation, pollution reduction, fish and wildlife enhancement, municipal and industrial water supplies, and recreational opportunities.

A vital part of the Reclamation effort has always been an insistence on structural adequacy in all its dams. This agency has developed a comprehensive system of testing and instrumentation, provided surveillance and instructions for operation under both normal and emergency conditions. In progress, particularly at older dams where new streamflow data have accumulated, are studies on the adequacy of spillways and other facilities.

But there is a related area of need. Many dams, which are not Bureau of Reclamation structures, are on our rivers and streams—some operated by organizations with a responsible safety maintenance program, and some without. An upstream storage dam not properly cared for, if it gives way, might seriously affect a well-managed downstream structure. Then a stair-stepping, or domino reaction, could result in one or more dam failures downstream bringing disaster to a whole settled valley. Thus, dams which do not have a safety maintenance program are a critical threat.

For this reason, I feel it necessary to emphasize the stand this agency has long affirmed: That the earliest possible date is none too soon for all owners of dams, who have not done so, to recognize their responsibility of adopting careful surveillance and maintenance programs to prevent and correct conditions which could become dangerous to other important water structures—and to an unsuspecting public.

Floyd E. Dominy

FLOYD E. DOMINY
Reclamation Commissioner

Large and Small—

Dams Save and Serve

by FLOYD E. DOMINY, RECLAMATION COMMISSIONER

SEVERAL months ago our First Lady, Mrs. Lyndon B. Johnson, said Glen Canyon Dam is a "dramatic element in the whole story of water conservation."

The noteworthy dedication commemorated the full operation of that conservation giant in storied canyons of northern Arizona. The 710-foot high structure takes its place among such other large Bureau of Reclamation dams as Hoover, Grand Coulee, Trinity, Yellowtail, Hungry Horse, and Shasta.

These dams have appropriately been called engineering wonders because of their size and design. And in terms of their usefulness in generating power and impounding water, they also are water conservation giants. The capacities stagger the imagination. Their operations are multiplying benefits and opportunities in large proportions over their costs—and their direct costs are being repaid to the U.S. Treasury. Reclamation dams also contribute significant advances useful on other dams now being and yet to be built, both here and in many parts of the world.

Reclamation's 66 years of dam building shows, however, that dams need not have gargantuan stature to achieve giant goals. For example, Altus Dam in southwestern Oklahoma could scarcely be considered giant-sized. This concrete structure, a rare product of World War II construction, rises only 110 feet above its foundation on the North Fork of the Red River, and it has no power generation features. Yet it serves as the key unit of a valuable reclamation project:

- Altus Dam provided water to irrigate nearly 38,000 acres of lands in 1966 which produced crops valued at more than $4.3 million.
- It has storage capacity of 10,000 acre-feet of municipal water reserved for the City of Altus.
- It helps to control flood threats of the Red River system.
- And it provided over 900,000 visitor-days of recreation in 1966.

Water Salvage

One of the newest additions to the Bureau of Reclamation system is Senator Wash Dam, a 94-

Learning something about harvesting potatoes are little Celia and Estelia Martinez, whose father worked nearby on Reclamation's Colorado-Big Thompson Project. *(Photo by A. E. Turner)*

This scene in Oklahoma last August showing water flowing both left and right from Altus Dam and reservoir, is an example of how th dam makes it possible for people in the valley to grow valuable crops every year. It also supplies recreation, flood control and municipa water for the city of Altus.

foot-high, offstream pumped storage dam on the California side of the Colorado River. Completed in 1966, this project is planned to salvage 170,000 acre-feet of water each year and makes possible improved deliveries to irrigated farms in the United States and Mexico.

Economically speaking, the dam and regulating reservoir provide conservation benefits totaling nearly $5.5 million annually. The water conserved by this project is sufficient to serve the municipal and industrial needs of a city the size of Denver or Phoenix, or to irrigate 27,000 acres of land.

No staggering dimensions of height, bulk, or girth are for Minidoka Dam, but this senior member of Reclamation's family of dams rates high in production.

Arizona, New Mexico, and Oklahoma were not yet States; Theodore Roosevelt was in the White House, and San Francisco was just recovering from its tragic earthquake when Minidoka began her long years of uninterrupted service to southeastern Idaho. That was in 1906, and Minidoka Dam continues to serve.

First Reservoir

Minidoka was the first of Reclamation's storage reservoirs to be completed, the forerunner of 269 Bureau storage facilities which now help to meet the Nation's ever-growing needs for water.

As the dams have grown in size and number, so, too, has their design and construction become fa more sophisticated than their predecessors. An ex ample of one of these updated achievements i Flaming Gorge Dam on the Green River in north eastern Utah. A thin-arch concrete structure, it i a key multiple-purpose unit of the Colorado Rive Storage project.

Flaming Gorge Dam was 7 years in the building It has a huge water storage and hydroelectri power capacity. In the first full year following th dam's completion in 1964, more than 800,000 visitor-days were recorded, and Flaming Gorge Reservoir surrendered 1.9 million sport fish to anglers— this from an area that had no recreational appeal and no fish to pursue with rod and reel in its natural state.

There is considerable education, experience, research, and time represented in the graceful facade of a dam. To bring this investment to bea on every assignment, the Bureau's Engineering and Research Center in Denver is organized for th most efficient possible coordination among such disciplines and responsibilities as: project investigations, design, research, engineering geology, drainage and groundwater engineering, irrigation operations, power operations, and construction. Like a delicate instrument of many parts, each of these services are vital to the others. No multiple-purpose Reclamation project could reasonably be assembled with any of these services missing.

Many Functions

So, too, is a dam a single structure of many tested functioning categories.

In Flaming Gorge Dam, for example, the construction schedule required 238 separate line items ranging from track for a 65-ton gantry crane to 535 tons of liquid asphalt; from handrails to special thermometers. Although it may be a thin-arch structure saving more concrete than some other designs, nonetheless the dam required 987,000 cubic yards of concrete—enough to build a two-lane highway stretching from Los Angeles to San Francisco.

Long before the first rock was blasted or the first concrete form filled, work was underway on other stages of Flaming Gorge Dam.

From 1957 until 1964, men representing various professions and trades, using great amounts of materials and equipment swarmed unceasingly over the remote canyon site. They magically brought the structure rising from bedrock of the river it was to master.

Expensive though they may appear at first glance, modern dams enjoy economic distinction throughout their long service. They are, first of all, mature at birth. In the case of Flaming Gorge Dam, it and its powerplant represent an investment of $65 million—roughly equivalent to the cost of eight modern jet airliners or 30 miles of Interstate highway.

Full-Blown

From the cradle of their concrete forms, dams step out full-blown and robust as working, producing members of the region's and the Nation's economy. They store valuable water for farmlands whose increased productivity means food for the world's dinner tables—water for growing towns and cities—for fish, wildlife, and public recreation—for producing hydroelectric power used in farm operations, homes, and industry.

Dams regulate the rivers downstream, minimizing or even preventing floods which otherwise would result in costly damage. Their lakes may act as settling basins preventing silt from choking rivers and making them more capable of supporting fish and wildlife. They sometimes form important highway crossings over the rivers.

Rollin' Along

Just as "Old Man River Keeps Rollin' Along," as the song goes—so do dams stand remarkably indifferent to the passing years. Sometimes they contribute a great many more benefits than their designers dreamed.

This was true with Grand Coulee Dam in Washington. When this structure was started in 1933, not even the far-seeing eye could predict the wartime contribution it would make a decade later. Grand Coulee's first turbines—344,000 kilowatts put on the line in 1942—played the key role in the aluminum industry which was needed for airplane production and the rise of the greatest air force in this history of the world.

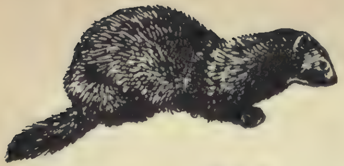
And the future bounds of Grand Coulee's immense service is nowhere in sight.

As in years past, water problems still pose challenges. The scope is broadening. Reclamation is now engaged in comprehensive planning of far-reaching programs to meet the needs of river basins in Western States for the next half-century.

Handling the atmospheric water resources program of augmenting usable streamflow by increasing precipitation through cloud seeding also is a significant role. Dams in place and others to be built, will be important in storing the runoff resulting from this artificially induced snow and rain.

As Reclamation takes on such added responsibilities, as are designated by the U.S. Congress, we are mindful that our multiple-purpose water resource developments, large and small, are the modern symbols of the pioneering spirit, and have played an integral part in the wealth of this country. Our long experience in this field is urgently needed, and the goal for our projects is to continue to SAVE AND SERVE. # # #

Today's fun is tomorrow's water—IF you have a dam at a lower elevation to catch and hold the melting snow when it flows during short spring months.



Dig this—A COOL MINK PAD

FLOWER persons of the present hippy set may not dig fur bearing ways. But to other people, valuable pelts are produced at a certain mink pad—like from COOL WATER, Man.

For the nonhippy reader interested in gainful pursuits, the foregoing possibly means—Cool water pays bigger dividends than warm water does to the owner of a mink farm.

Mink farming challenges one's ingenuity to obtain a profitable harvest. And it has been found that sprinkling cool water on the roofs over the animals will cool them in hot summers, causing the mink to eat more and grow bigger pelts, in the case of the 14,000-mink farm of Albert Larson near Spokane, Wash.

The water now available—being about 30 degrees cooler than formerly—makes the mink harvest even more efficient and profitable. New pumps bring the water from wells at 47°. Previously the source was the Spokane River at 77°.

Wells now tapping an extensive reserve underground lake, plus a system of elevated tanks and over 86 miles of buried pipelines provide the water service to the Spokane Valley area where Larson's farm is located. The farm is on the Bureau of Reclamation's Spokane Valley project. With construction starting in 1964, the recently completed features of the Reclamation project include a distribution system for municipal and industrial water and irrigation service to 7,250 acres of land. The new facilities replace a deteriorated system of canals and flumes relying on direct diversions from the Spokane River that became prohibitively costly to maintain.

Mink Man's Needs

The successful mink farm requires a large capital outlay, long hours of work, patience, individual care, a thorough knowledge of the environmental habits of the small furry animals, and a "crystal ball" on the variances of the market. However, in return for this attention to their needs and their VIP status, mink give their best—shirt off their back, so to speak.

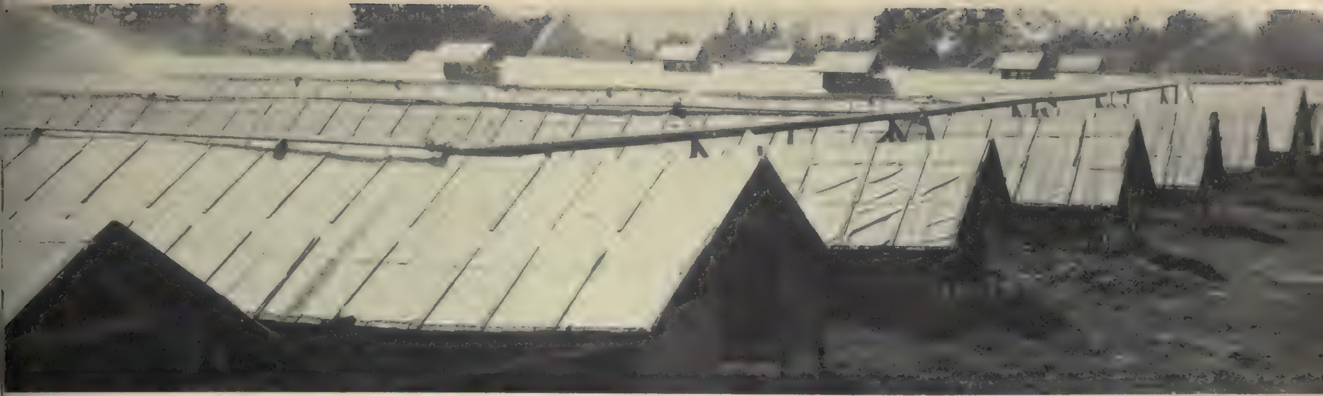
Larson started his operation modestly 26 years ago in the Greenacres area of Spokane Valley with a few animals and a single shed. He has been using the sprinkler system to cool his facilities for 10 years.

In colors of blue, pearl, violet, and various shades of brown furs, Mr. Larson's minks are raised in individual wire mesh cages in the long sheds with open ends and sides. On each shed roof is a line of low head sprinklers. Just as irrigation water boosts the yield of crops grown in the ground, sprinkling on the mink sheds brings about 1½-inch longer pelts for a better market price. Sprinklers reduce the temperatures inside the sheds at a more constant 20 to 30 degrees, which is most important during the maturing phases of the crop.

Because the water makes grass grow heavily between pens, calves are ranged in the area to keep the grass eaten down. Then in the fall, all the employees get a beef, said Mr. Larson.

March is the mink breeding season and the new litters are expected in May. Litters vary in number from one to 12 kits, with an average of four to five. The young are retained in the breeding pens until they are weaned, then they are moved to the furing pens. Of the 14,000 adult minks on the farm, the carryover crop is 2,200 females and 450 males after the pelting in December and January.

The once-a-day feedings include 8 ounces for the female and 12 ounces for the male, totaling



14,000 mink think it is raining——it's birds——the air-conditioning?

ıbout 5 tons of feed served to the population. On he menu is ground-up parts of unsalable chicken, beef liver, fish, and cereal.

'eed Locker

The feed preparations are done on the west coast where raw materials are readily available at a reasonable cost. Also, Mr. Larson maintains a 00-ton frozen food locker on his Spokane spread. The feed is removed from the locker for thawing, and the next day it is mixed to a formula and distributed to the animals with semi-automatic machinery.

The handling of the sacks at the mixing hoppers and distribution of the feed is done by hand. A special dolly cart carries the mixed feed under pressure. An operator riding the cart down an aisle between the cages is able to direct the feed into the cages through a flexible hose with a hand-operated nozzle. The aisle also is wide enough for small motorized spray tanks and service vehicles.

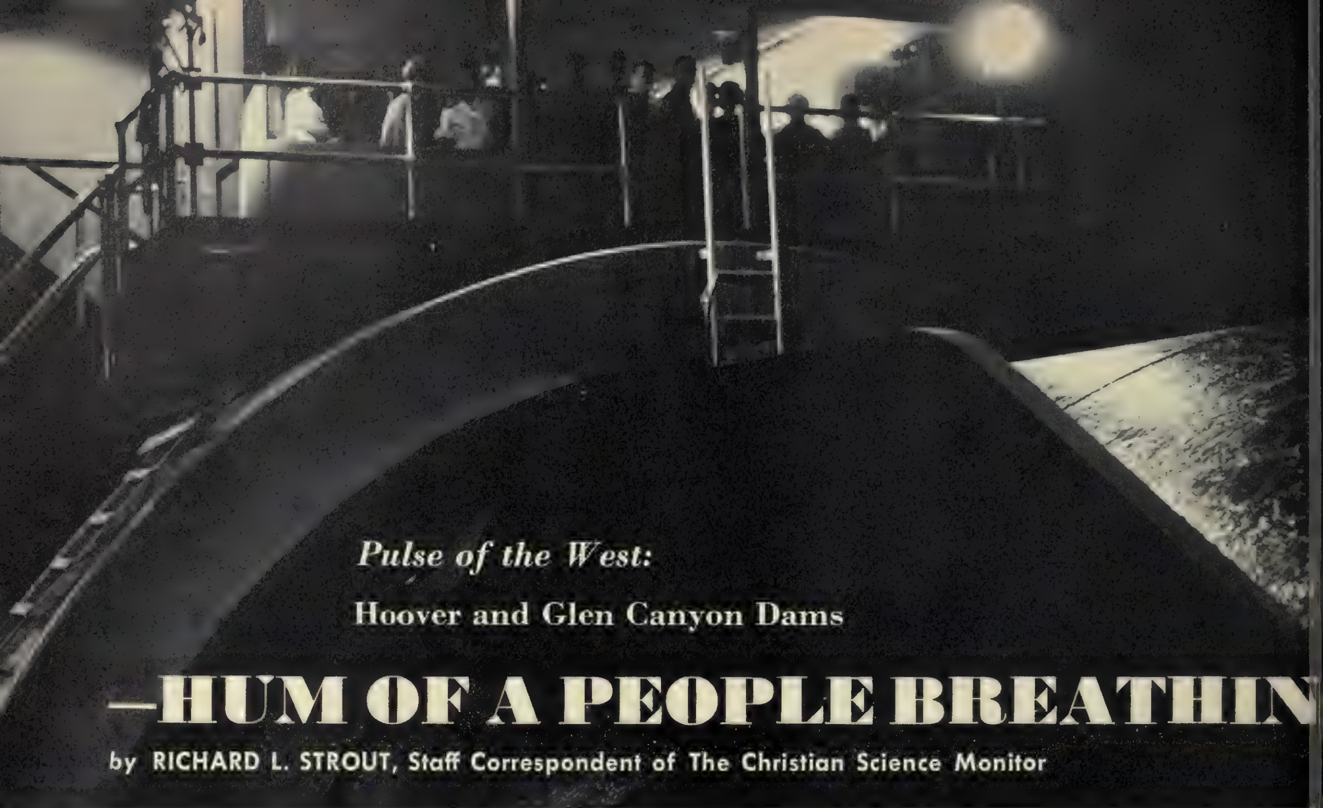
Water is not only made to rain on the roofs of this 20-acre farm. It also is brought to each cubical through pipes and individual taps. During hot weather, the pelt animals can, in addition to getting a cool drink, take a refreshing dip whenever they feel like it.

Nine full-time men are employed during summer at the farm, four in winter and 12 during pelting. Larson said women employees are assigned to tailoring the pelts as the women are more particular than men in this process. Because 60–65 pelts make one mink coat, the tailoring process is a very important step.

The pelts are shipped to Seattle, Minneapolis, and New York where they are sold at auctions. The cost of raising a mink is $15 (1966 figure) which pays for its food, the labor, and the processing of the pelts for market. Some pelts bring up to $75 each, and cool water helps this to happen.

# # #

A thorough knowledge of the small furry animals is essential to make profit on a mink farm. Use of heavy leather gloves protects from sharp captive teeth. Mr. Larson, right, is holding a brown mink and Oscar Liere holds one that is pearl colored. When taking the mink out of their pens, the tail gets used as a handle to keep the showoffs in tow.



Pulse of the West:

Hoover and Glen Canyon Dams

—HUM OF A PEOPLE BREATHIN

by RICHARD L. STROUT, Staff Correspondent of The Christian Science Monitor

The small bomber circled till it pinpointed its target and then, at 300 feet, a quarter of a million live rainbow trout Niagara-ed into the air for a free fall. As they descended, one fingerling said to another, "I do hope Lake Powell is all that Bobby Kennedy says it is!"

Like most Easterners, Mary and I didn't know much about the Colorado. They plugged the river in 1936 with the Hoover Dam and created Lake Mead, and they plugged it again at Glen Canyon in 1963, farther north, and created Lake Powell.

This superb curved 700-foot dam at Glen Canyon (2 miles away from Page) is as lovely as a Greek sculpture.

But the statistics to remember are that the 1,400-mile Colorado River, fed by Rocky Mountain snows of Colorado, Wyoming, Utah, and New Mexico, flows south through Arizona, Nevada, California, and Mexico to the Gulf of California—a vertical drop of more than 2½ miles—and it drains one-twelfth of the area of the 48 contiguous States.

An Eerie Appeal

As to fish, they're the simplest part of it. The Government has impounded one of the most astonishing recreation areas in the world. The strange combination of blue-green water flowing throug arid cliffs, produces eerie appeal. The authoritie have shrewdly accentuated this by giving a non parachute descent so far to 14 million trout an large-mouth bass. The fish that don't survive th trip, motorboat examination indicates, wouldn fill a bathtub.

Very well, then, here is another anecdote of thi singular place. The receptionist at Art Greene motel at Wahweap (just above the dam) turne around and here was this large gorilla who said t her, "Will you please check my guitar?"

Mr. Greene says the receptionist jumped a foot but she says it was only so much.

It was the latest Hollywood team using thi extraordinary setting for a picture that hasn been released yet, "Planet of the Apes," or some thing like that.

Ed Lonergan (Edward R. Lonergan, Cit Administrator of the Bureau of Reclamation planned community at Page) told Mary and m that he hadn't been able to follow "The Greates Story Ever Told." He spent the whole show iden

Public on tours reach a platform in the depths of renowned Hoo Dam, 560 feet from the top. They look down on a giant pensto and view many inner workings. (*Photo by John Miles*)

tifying the local peaks and buttes where Jerusalem and Bethlehem and the rest had been erected. He plans to see the film a second time and concentrate on the drama.

Camels and Donkeys

If you have ever been to Petra in Jordan, the "rose-red city, half as old as time," you will see the same red sandstone as here in which a forgotten race carved its temples in living rock.

What a place to name-drop! That's the motel where Princess Margaret and Lord Snowden stayed, and here's where the Bobby Kennedy kindergarten and Art Buchwald started their downriver course, and over there was where they kept the camels and donkeys and Hollywood stars for "The Greatest Story," and Lady Bird was here, and now this new picture, "McKenna's Gold," or something like that, is being made.

For me, though, it's the hum of the generators.

There are eight of them here and 15 at Hoover. The huge smooth curve of the dam is a poem, of course. And the sight of cars tugging motor boats through the tortured rocks of a desert, well, you have to see that to believe it. But the hum of generators is the breathing of a people.

Folks go to sleep, and some of the generators shut down from midnight to 7 a.m., and the sluices close, and the water backs up a bit. (Power isn't lost; the water that whirls the turbines is just impounded.)

Then in Denver and Salt Lake City and Phoenix and Tucson the electric toasters switch on for breakfast. And from the big, windowless, laboratory-clean operations room, backed up against a sea of pushing water, the engines advise central control, "We need another generator."

Pulse of the West

The heat of the day increases, and Tucson will take more current for air conditioning, or the pumping starts on irrigation miles away, and the two aluminum wires spun round a steel core that go marching off to Phoenix, 180 miles away, carry the load.

Provo, Utah, or Cheyenne need more power.

An aerial fish planting in Lake Powell above Glen Canyon Dam, Ariz. (*Photo by Mel Davis*)

Cartoon—Hollywood characters arrive.

The quiet man can read the pulse of the West—here comes the afternoon peak at Shiprock or after sundown, another peak as mom does the dishes. Dad settles to his paper, and the children switch on TV.

The generators respond to the mood of the hour, the month, and the year. Daylight saving made a big change. You can tell the temperature the state of the crops, the drought, or the Saturday night bulge by those dials. There's power here for a city of a million and a half, whether for the gaudy "Strip" at Las Vegas or the lonely light twinkling on the prairie.

Another striking thing: The central control isn't here but at Montrose, 250 miles off. There an IBM calculates power, river flow, and demand of all the interconnected Upper Colorado powerplants, of which Glen Canyon is largest.

Uncanny Supervision

The automatic supervision is uncanny: Montrose sent word that an elevator at Glen Canyon needed attention; they could tell by a jiggle on some dial, and noticed it before the local boys did.

With all this electricity about you would think the local rates would be low, but no, that never happens, no more than you can get cheap orange juice from a quick-lunch in Florida.

The Government doesn't retail any of its power; it all goes wholesale to private or municipal companies. But recently an intercontinental intertie has been setup. Time zone by time zone. The Colorado plays its part. The great rogue river has been tamed. # # #

(*We extend our appreciation for this article to author Mr. Strout, and for the illustration on this page to Gene Langley. The report is tenth in a continuing summer series from Correspondent Strout assigned to tour the United States. Reprinted by permission from* "The Christian Science Monitor," *Printed in the Aug. 4, 1967 issue.*)

On First Evaporation Reduction Film

The Bureau of Reclamation is preparing a documentary film report on its research efforts to reduce the enormous evaporation losses from large lakes and reservoirs.

A joint effort by the Bureau and the Environmental Science Services Administration, the 30-minute motion picture is believed to be the first on this subject. It will detail the Bureau of Reclamation's 1966 evaporation suppression research program at Lake Hefner, Okla. The full-color film is expected to be available to technical audiences by early 1968.

Bureau Reservoirs Avert Flood Losses

The dams and reservoirs of California's Central Valley project during the past 17 years have prevented downstream flooding which would otherwise have caused $285.4 million in damage.

The flood control benefits from the CVP were the greatest among the estimated benefits derived from any flood control or reclamation project in nine Western States.

The next largest estimates of savings through flood control were $96.2 million from the mainstem reservoirs of the Colorado River Storage project.

During the 17-year period from 1950 to 1966, flood control operations on the Bureau projects have prevented a total of more than $600 million in flood damages. The figure is well above the $556 million allocated to flood control costs on all projects authorized as of June 30, 1966. The value of damages prevented has exceeded greatly their cost of construction.

Planning a Huge Project
In North Dakota

Know HOW to Switch to Irrigation

Few sights quicken one's heart more surely than a well-developed farm in a good location. One such favorable location is in North Dakota. But agricultural beauty, such as irrigation water would provide, has only been dreamed for 75 years by most families in that area; now it is being planned in every way possible.

In addition to an irrigation system bringing a stabilized and diversified agriculture to 250,000 acres of semi-arid but fertile land, and ultimately to over a million acres, the multiple-purpose initial stage of this Bureau of Reclamation, Garrison Diversion project in North Dakota will supply municipal and industrial water for 14 towns and cities and four industrial areas.

Initial efforts, which may take about 25 years to complete, also will enhance fish and wildlife resources at 36 major areas and numerous smaller areas, and will develop recreational opportunities at nine major water impoundments.

Authorized by the U.S. Congress in 1965, the Garrison Diversion Unit of the Missouri River Basin project got underway last July with an order for three large water pumps and motors to be completed in 1971.

In the next few years, as water becomes available to them, landowners who have holdings designated as irrigable lands will be deciding just which changes to make. Irrigation will be new to most farmers in the project area. It will mean integrating, or operating a combination of both dry farming and irrigation.

Water levels will go back up this pole as developments get underway on the Garrison Diversion Unit. The unusual marker in the Devil's Lake area shows the lake at 1,437 feet elevation in 1870, but it receded an important 25 feet by 1963.
(Photo by T. R. Broderick)

283-905 O - 68 - 2

Irrigation Know-How

To accomplish this, the farmer will need more know-how for irrigation than he has for dry-farm operations. But there is considerable evidence to show that today's modern farmer will have little or no difficulty to adapt either himself or his operations to these changes.

In fact, he will probably be more efficient and successful because he does not have unproductive customs or ideas to contend with. He can readily accept proven irrigation methods.

The farmer of today recognizes that his farm, in fact, is a business. He knows his earnings result from selling his goods for more than the cost of production. His decisions, many of them daily, not only govern his work but likewise affect his income.

Abandoned and not at all in good shape is this old farm on land in North Dakota to be developed with irrigation.

Any change in operations, such as a transition to irrigation on some lands will require careful planning. The businesslike way is to: (1) assemble facts, (2) seek expert advice and guidance, (3) decide on how and when to proceed, and (4) go ahead, based on the plans.

Farmers now relying upon small grain production will likely find other crops more rewarding and a better chance of stabilized income with irrigation. In some instances the size of the farm may change, and cash crops to be grown will need study. Some new machinery and specialized irrigation equipment will be needed.

Becoming imporant are the timing of irrigation water delivery, and how fast the farmer will want to develop his land during the 10-year development period when advantages on proposed charges are a premium. Probably of most importance will be his financial capability to handle the added investments involved in irrigation.

Getting Facts

One of the best ways for the potential irrigator to get facts on transition is to learn directly from an irrigation farmer. Usually irrigation projects offer a good chance to see a wide variety of operations.

Many of the potential irrigators in North Dakota have already visited several irrigation projects. They have been able to talk to many farmers, businessmen in irrigation communities, and persons engaged in the processing and marketing of diversified farm products.

Among projects being operated for irrigation and other purposes which they have visited are the Lower Yellowstone project in western North Dakota, the Columbia Basin project in central Washington, the Colorado-Big Thompson project service area of Colorado, the North Platte project in southeastern Wyoming and western Nebraska, and the Niobrara-Lower Platte projects in Nebraska.

An irrigation specialist who will be employed to provide individual guidance is a service to be provided by the irrigation district.

At the start of planning, one of the first "tools" needed will be maps of the farm showing the potentially irrigable lands. Such maps show soil and drainage characteristics, the topographic relief, and proposed layout including turnouts for the incoming water and outgoing surplus waters. As such information is discussed it is seen that physical land characteristics have much more significance under irrigation than under dryland farming operations.

For example, soil textures, depths and structure are especially significant considerations. Soil is

like a tank—it has a capacity to hold and store water.

Soil Intake

Also important is the rate water will move through the soil, and its intake rate. Soil textures often dictate the crops which can be successfully grown, and depth of soil has influence on root development as well as capacity to hold water. Knowing such things are among the first concerns of a new irrigator.

Sizing and shaping of fields can be determined from topographic maps. This can dictate the type of irrigation that should be employed—surface or sprinkler irrigation. Reviews with the irrigation technician will make known the merits of gravity or sprinkler irrigation and the proper water control on the farm.

This examination for an individual farm should also take care of acres of dry farming. And it should include cropping data, soil management, machinery and equipment requirements, and certainly not least, an estimate of costs involved.

The joint review needs to be done at an early date. Even though the farmer may activate his plans in a period stretching over several years he will be making sure it all fits into the overall plans.

The irrigation reviews bring other dividends. The farmer's plans can have an effect on the project system and its construction. Because of his experience, the irrigation technician working with individual farmers will probably be the same person who will, from time to time, confer with construction forces on water deliveries for the entire service area.

Leveling

The landowner planning irrigation likely will call on the conservation district representative to arrange land-leveling operations. Fields would be staked to get proper grading. Staking would also be done for construction of the irrigation ditches, structures, and drainage ways.

Then the farmer will arrange for work by a leveling contractor which would be supervised and inspected by the Soil Conservation Service. If, on the other hand, a farmer decides on a sprinkler system, it would be probable that, with technical help, he will complete his deal with a local supplier.

A number of State and Federal agencies now have programs to help farmers establish irrigation. To assure that all assistance programs are

When the Reclamation project causes return of water, such alkali beds as the one shown will be returned to usefulness, and fish and wildlife habitats improved.

coordinated and available when needed, the various agencies have pledged their cooperation and participation in an Irrigation Council.

Engineers and various agricultural experts have been organized to provide team effort and make the overall irrigation project successful. The Council will function through work groups.

Each work group will have specific areas under study and will develop recommendations regarding farm irrigation methods, irrigation farm management, financial assistance, engineering assistance, community impacts, development of markets and processing facilities, and other irrigation matters. Work groups, reporting to the Irrigation Council, will make their recommendations available to all other agencies, but more importantly for use of individual farmers developing irrigation.

Council In Garrison

The Irrigation Council of the Garrison Diversion Conservancy District is expected to provide handbooks, circulars, and other means of presenting technical information on irrigation, tillage, soils management, variety and fertilization recommendations, crop management, and other details of irrigation cropping. No doubt the farmer will also have this type of irrigation guidance and information available from his county extension agent.

In the Garrison Diversion Unit, water charges have been scheduled at the time of water availability in such a way that a farmer's average ultimate water charge in the first year would start at 10 percent. Thereafter it would increase 10 percent each year until reaching the full charge. In this way, any farmer who develops his land at a faster rate than scheduled would find his average per acre water charges to be cheaper. A farmer developing irrigation will want to investigate cost-sharing programs.

In many Western States, development of gravity irrigation is partially financed by payments as a soil conservation and stabilization practice. This varies with localities, and, of course, must be approved as a practice in local programs.

Getting Ideas

A year or two of irrigation experience for a dryland farmer gives him a "wealth of ideas" on how irrigation water is controlled, together with other techniques of water application. He is then ready to make plans for his entire acreage. He gradually becomes more proficient in utilizing this "new resource" to his inherently productive land.

As the new irrigator becomes an experienced and seasoned irrigator, his entire outlook undergoes a tremendous change. He soon learns that his irrigated land is most important, and gives it priority in his farming. This happens because irrigated crops enjoy an insulation from unpredictable rainfall, and there is more flexibility—a better chance to shift crops according to market conditions.

The irrigator also will find that his farm, like in many other Western areas where bringing water to the soil is now a "way of life," is good for him, his family and his country. Each year this life-sustaining resource will be more important than ever—it becomes a more valuable legacy for the generations which follow. # # #

Highly Sensitive Testing Device

An elephant's foot may be mighty sensitive, but not as sensitive as a 10,000-pound research tool designed and built by the Bureau of Reclamation's Engineering and Research Center at Denver.

This ponderous unit will enable engineers to detect movements as slight as one ten-thousandth of an inch deep inside a rock wall when pressure is applied.

The new device is a radial jacking test unit which may be employed at the sites of proposed dams to determine if the surrounding rock structure can support the extreme pressure generated by the dam and the water it impounds.

ıbitat Management Near ellowtail Reservoir Is ıying Big Dividends for rd Hunters

Birds by the Acre

ory and photos by TIM BRITT
Wyoming Game and Fish Dept.

One of the newest and largest developments for outdoor recreation in Wyoming is already paying dividends for Wyoming sportsmen. This new recreation area centers around Yellowtail Reservoir.

The dam, completed in the fall of 1966, is located on the Big Horn River in Montana. Behind the dam structure a reservoir 70 miles in length has been formed. A large portion of the new Yellowtail Reservoir is located in the spectacular Big Horn Canyon. In Wyoming, however, the lower end of the reservoir (upstream end) widens to form a relatively shallow body of water 2 miles wide.

The Yellowtail project, carried out by the Bureau of Reclamation, forms a nucleus for tremendous opportunities in outdoor recreation. Campers, tourists, rockhounds, boaters, sightseers, and hikers will find the area rewarding. The potential, at this time, has barely been touched, however. Future years, accompanied by careful planning and wise development, will bring the realization of the many values of the Yellowtail project.

Hunters and fishermen are already reaping many benefits from the area. Because fish and wildlife play an important role in the overall recreational potential of the Yellowtail area, the Wyoming Game and Fish Department has been intimately involved with the project since its beginning.

Maximum Wildlife

In order to realize the ultimate in wildlife benefits from the area, a special unit, comprising almost 9,000 acres, has been established. This area, known as the Yellowtail Habitat Unit, is managed for maximum wildlife production.

Approximately 9,000 acres on the Big Horn and Shoshone arms of the reservoir have been assigned to the Department for management as a habitat unit. Over 500 acres were purchased by the Wyoming Game and Fish Department, 2,700 acres were acquired for habitat management under the Fish and Wildlife Coordination Act from the Bureau of Reclamation, and 5,300 acres were acquired from the Federal Government under the same act.

The topography is such that the land features establish a natural boundary around the unit. The Habitat Unit lies in the shape of a "delta" formation. With the exception of two or three packets

Game birds like this juvenile pheasant have a much better chance of survival when habitat is properly managed.

there is no deeded land within the naturally bordered area. The entire unit is surrounded by arid, barren, rolling hills with the exception of the upper end of the Shoshone Arm.

Irrigation and Marsh

Within the unit there are 2,100 acres of fertile farmland and several irrigation ditches make crop production possible. Approximately 246 acres of marsh in several locations are located within the project boundary. Two major rivers, the Big Horn and Shoshone, are located within the Yellowtail Wildlife Unit.

The Big Horn traverses the area from south to north and the Shoshone River enters the unit from the west. The main river bottoms contain about 4,000 acres of dense trees and shrubs. The remainder of the unit consists of arid, barren fringe lands and hills.

Development of the Yellowtail Unit began on June 1, 1965. Wayne Darnall was named unit manager by the Game and Fish Department. Prior to this assignment Wayne had been manager of the Whiskey Basin and East Fork elk winter ranges near Dubois. Until recently he was assisted by Ken Asay who is now manager of the Ocean Lake Unit. Bob Larson is currently assistant manager at the Yellowtail Unit.

According to Manager Wayne Darnall, the development of a new unit is no easy task. "When I first arrived at the Yellowtail Unit things were pretty indefinite. The unit consisted of what remained of several farms that the Bureau had purchased in the impoundment area. The reservoir had not filled and we had only a vague idea of where the shoreline would be located."

Unlimited Potential

"The unit is managed primarily for upland game bird and waterfowl production," the unit manager explains. "The lay of the land, the proximity of water, the agricultural development, and the natural vegetation provide the unit with an almost unlimited potential for upland game bird and waterfowl species. The basic objective of the unit is, of course, to provide as much recreation as possible for the sportsmen of Wyoming."

Pheasants, chukar, and Hungarian partridge, bobwhite quail, sage grouse, sharptail grouse, wild turkeys, Canada geese, mallards, redheads, bluewing, and greenwing teal, as well as many other species of waterfowl, are all present on the unit.

Habitat management usually means habit[at] manipulation. The theory behind the fact cal[ls] for providing the life requirements of game s[o] that the game will derive the greatest benefits fro[m] the land. This means that food and water, nestin[g] areas for production of broods, and cover for pro[tection] against predators and weather are planne[d] and arranged to produce the greatest number o[f] birds.

An example of habitat manipulation would b[e] a square mile planted to corn. The field would pro[duce] only a few pheasants each year. Althoug[h] food would be plentiful during specific times o[f] the year other life requirements would be lacking. If this same field were broken up into small patche[s] of cereal grains, legumes, and brush, and wate[r] were made available, the same area would produc[e] many more birds. An area producing all of the li[fe] requirements of a species in close associatio[n] demonstrates what is known to game managers a[s] the "edge effect."

State's Finest

The Yellowtail Unit displays what is probabl[y] the finest natural pheasant habitat in Wyomin[g]. With the use of habitat manipulation, the carryin[g]

Unit Manager Wayne Darnall and Bob Larson inspect a goo[se] nest built in the marsh development. Many species of waterfow[l] prefer shallow marsh areas for feeding and nesting.

pacity of the area can be greatly increased to rovide even more birds for the hunter's bag.

Part of the challenge of developing a unit such Yellowtail is the proper management of the nd. The "edge effect" does not merely happen. onths of study and preparation go into the final roduct. This is the problem of the unit managers.

The actual farming and use of the land is car- ed out on a sharecropping basis. Wayne Darnall d Bob Larson must figure out what fields are to farmed, what crops would be most beneficial the game bird species present in the area, and ntact individuals to work the land. The farmers

Lots of birds and plenty of room—8,700 acres—make the Yellowtail Habitat Unit a bird hunter's paradise.

tain 70 percent of the cereal crops and 60 percent the hay for their efforts. The remainder of the ops are left in the fields for wildlife food and ver.

It is the duty and responsibility of the unit anagers to see that crops are planted and cared r according to the wildlife management plan, at irrigation waters and facilities are available d properly used and that the game's share of the op is left in the field.

esign for Ringneck

Ring-necked pheasants and quail are almost tally dependent upon agriculture for their exist- nce. Pheasants are the most popular and most bundant species of upland game birds on the ellowtail Unit and the agricultural areas of the nit are designed with the ringneck in mind.

Bobwhite quail were introduced to the unit in March 1961, and a subsequent release was made during the fall of the same year. Although quail have not been planted since it appears that this species has taken hold. The quail have extended their range naturally since their first introduction and the population seems to be increasing.

Chukar partridge were introduced into the Big Horn Basin areas in the early 1930's. The arid sagebrush land edging the cultivated lands is well populated with chukars and they often move into the cultivated lands to feed. Hungarian partridge are also found on the unit and become fairly numerous during some years. Sage grouse and sharptail grouse occur on the unit but their populations are low.

Turkeys

During November of 1966, 13 wild turkeys were introduced on the unit. At least seven of the birds survived the winter and several are known to have nested this past fall.

Although dense cover definitely benefits the upland game birds during various periods of the year it can be a definite handicap to the hunters in the fall. In order to help attain a proper harvest livestock grazing is utilized to break up some of the dense cover. The reduction of cover permits hunters better access to hunting areas and allows hunters to flush birds. In extremely dense areas access and flushing trails are cut through the brush

Yellowtail Unit displays what is probably the finest natural pheasant habitat in Wyoming.

with a mower. Grazing is allowed after crops are harvested and the hunting season has ended in cultivated areas. In other areas livestock is permitted throughout the year.

Habitat management for waterfowl also involves habitat manipulation. Three methods are used extensively on the Yellowtail Unit. These include construction of marshes, production of food, and development of nesting areas.

400 Acres

At the present time six marshes have been built, and the unit has a potential for 400 acres of marshland. Duck species that do not feed on cereal grains prefer marsh areas where the water depth does not exceed 12 inches for feeding. The marshes are constructed so that each may be drained to allow vegetation to grow during the summer. The marshes can then be flooded when the fall migration of waterfowl reaches the area.

Food for waterfowl is also produced on the cultivated areas of the unit. In the spring nesting, geese graze on the tender shoots of cereal grains. The cereal grains produced on the unit and left i the field attract migrating waterfowl in the fal Unlike upland game birds, larger fields are mo appealing to waterfowl. Geese especially like larg fields, harvested short, for their fall and wint fare.

Before the impoundment area was flooded ap proximately 100 large trees were left standing These trees are currently being topped above th maximum water line and fitted with halved 50 gallon steel barrels. In early spring these stru tures will be lined with straw so that they may b utilized by geese for nesting structures. Other of the-ground structures will be built in the mars areas to increase goose production. These stru tures reduce nest destruction by predators, ne flooding; and the honkers seem to like a home wit a view.

Whistles

Bob and Wayne are optimistic about this fal The fruits of 2 years' work are beginning to sho The birds, especially pheasants, are numerou Evening whistles from the thickets testify th quail are near.

"Last year we had to extend the hunting season, Wayne said. "After the first few weeks of the sea son hunters were few and far between. It seem that in most years the most lucrative pheasa hunting takes place after the first snow. The cove has thinned out somewhat, snow holds the sce so hunting dogs can work better and the bird bunch up after the first cold spell."

"Pheasant hunting on the Yellowtail Unit is n snap," Bob added. "The birds are here all righ but the cover is thick and the birds are wise. Yo won't get your birds the first 15 minutes but if yo like to hunt the illustrious longtails, I can't thin of a better place than Yellowtail." # #

(Appreciation for reprint permission of this arti cle and photographs is extended to the author an "Wyoming Wildlife" magazine.)

Reclamation Publishes Second Edition of Water Measurement Manual

Second edition of the Bureau of Reclamation's Water Measurement Manual, first published in 1953, is available for purchase.

The hardcover publication is a standard reference work for designers, system operators, and water users involved in water measurement tech nology.

Copies are available at $2.50 each from the Su perintendent of Documents, U.S. Governmen Printing Office, Washington, D.C. 20402, and from the Bureau of Reclamation, Engineering and Re search Center, Denver Federal Center, Denve Colo. 80225.

On Purpose—

A BETTER WAY TO TAKE WATER

Taking a drink of water because of thirst is ommonly done, of course. But a risk, which has een with man as long as thirst itself, is that of aking water accidentally—drowning—the times vater fills the lungs instead of the stomach.

Drowning is something we have to learn all bout how *not* to do. Young or old, the safety information has to be found out, but somehow, not ll of us do. Drowning represents the fourth leading cause of accidental death in the United States. Some 7,000 persons each year die from it, and the oll continues to climb.

To help people *not* drink water accidentally, at east around open bodies of water, are such slogans as DANGER—BEWARE OF DROWNING! THINK SAFETY! Going further than such signs to prevent water tragedies are various educational programs undertaken to vividly impress people on which personal precautions to take to avoid the problems. Also physical barriers to prevent happenings, and handling devices to aid in rescues have been constructed.

This is what "Operation Westwide" is for—and this is the 10th anniversary of the movement. It helps supply ideas and programs attacking water accident and drowning problems. In the 18 Western States, it is a joint program of the American Red Cross and the Bureau of Reclamation.

Rescuing sailboaters when their craft overturned was needed one windy day on Pineview Reservoir, Utah. No play in this incident, even hough it happened during an Operation Westwide water safety show. (*Photo by Stan Rasmussen*)

Such a concrete-lined canal as this would be more dangerous to drownings if it were not for the chain-link fence border, the warning sign, safety net hanging across the canal and the iron escape ladder at left. This is at Epharata, Wash.

It seeks community support for continuing operation and success, one of the prerequisites of volunteer programs. In its 10 years, many people in its area of operation have become more enlightened about water safety. Results are encouraging that the use of water safety regulations have been stepped up, also drownings in some areas have declined.

Launched in 1957, "Operation Westwide" is intended for effect in the areas around and on Reclamation reservoirs and canals. Reclamation water development projects have a total of over 11,000 miles of shoreline and 219 water-related recreation sites. As these facilities grow, the hazards for water sports and recreation increase. The facilities attracted recreation seekers at the rate of 45 million visitor-days in 1966. Also there is a recognized risk with youngsters, for example, who are unprepared for safety around Reclamation's 6,755 miles of irrigation canals.

Reclamation's policy on recreation is to encourage public use of its facilities which are particularly adaptable to such use, and the public widely accepts the opportunities.

Supervision Problem

However, there is seldom opportunity for the kind of close supervision of an urban recreation center because Reclamation facilities are relatively isolated and uncrowded. For this reason, the Bureau simultaneously widely promotes safety and constant personal carefulness for accident-free enjoyment.

One or more water safety rules have not been learned and tragedy is imminent, for instance, if a wind-tossed boat capsizes on a lake spilling its occupants into the chilly waters.

—or if an angler, intent on an eddy in a stream, blunders into a deep hole and panics.

—or if a youngster ignores a fence or warning sign and jumps into a fast-flowing irrigation canal for a swim.

Operation Westwide is designed to be practical and to emphasize such logical hazards associated with water recreation—what they are, where they are most frequently encountered, how to avoid or eliminate them. Also it provides information that it is the responsibility of each individual to act for his own safety and that of others accompanying him.

To test the program, pilot organizations known as Community Water Safety Councils were established in areas with pronounced water hazards. The first were the Yakima Valley Water Safety Council on Reclamation's Yakima project in central Washington, and the Boise Water Safety Council on southwestern Idaho's Boise project.

On the Yakima project, there are six major reservoirs, all providing recreational opportunity for some 100,000 valley residents. In 1958, the year

Words of warning painted in large letters should prove to alert some of water dangers. This is at the All-American canal facilities, Yuma, Ariz.

Operation Westside went into operation, Reclamation and Red Cross representatives arranged and attended meetings with government and business leaders, with service and civic groups, Boy and Girl Scout units, schools, sporting organizations—with anyone, who would listen and lend support. The proposal met with a warm response both in Yakima and Boise. Civic-minded residents came forward and moved rapidly to implement the water safety program.

Safety Materials

Using materials prepared by the Red Cross, the National Safety Council, U.S. Coast Guard, Bureau of Reclamation, and others, plus material adapted or original, the two pilot water safety councils conducted intensive programs in swimming and rescue instructions, boating safety and inspection, local and State safety legislation. The information-education effort also gained the enthusiastic cooperation of local press.

Encouraged by this early response, the Bureau of Reclamation moved to establish water safety councils in other hazard areas. The Governors of the respective States were advised, and offered their backing. Three additional councils were established in 1959, still more the year following. Today there are 30 Water Safety Councils in 14 of the Western States, actively dedicated to "waterproofing" the public.

Not for some time did the full impact of the program become apparent. Harold E. Wersen, Safety Engineer for the Bureau of Reclamation's regional office at Boise, Idaho, was among those who steered the organization of the first councils and watched their progress.

"In the 5 years before the Yakima Valley Water Safety Council was organized," Wersen recalls, "there was an average of 11 drownings a year in the area. During 5 years after the council was formed, drownings average 1.8 per year. There's no question that this organization has saved lives by developing real, genuine awareness among the public."

"Learn to Swim"

In many areas, "learn to swim" programs had trebled and quadrupled in enrollment. Lifesaving classes were filled. Demonstrations were held throughout the summer at beaches and swimming pools, there were workshops for parents and children, safety displays in local stores, school essay contests, Government proclamations, posters and decals, continuing publicity in all press media, surveys to locate and correct hazards. Also talks and demonstrations before civic, service, church and school groups on the urgent need to practice safety.

Everywhere, cooperation was excellent. In the Bureau of Reclamation's Region 1 area, for exam-

Self-rescue steps constructed into the end of this siphon on the Weber Basin Project, when in full use with water, will be helpful for persons or animals (such as deer) to climb out more easily.

ple, a brief safety reminder is printed on bills sent to water users by irrigation districts and water companies. Under the heading "Operation Waterproof," the message reminds of the dangers of irrigation canal, reservoir, stream, and pool, and adds:

"You can cooperate in this lifesaving program by instructing your own children in water safety, encouraging them to learn to swim, calling our offices if you observe children engaged in hazardous activity in our waterways, and permitting our personnel to use your telephone to promote this program . . ."

Safety officials of the Imperial Irrigation District in southern California created a Hollywood-type cartoon character named Dippy Duck, and made him a popular and easily identified safety symbol. He was prominently displayed in films, booklets, and posters circulated in the schools to encourage youngsters to "think safety." In Reclamation's Region 7, east of Denver, Colo., a "safety-pin" character was devised for poster use and circulated widely among school systems.

Construction Improvements

It also was evident that more physical improvements should be constructed in, on and around water recreation sites.

In 1963, the Department of the Interior established a special task force which directed a survey of conditions at 157 reservoirs and 46 canal or irrigation districts. At more than a third of these reservoirs, for example, there were no safety or rescue organizations. Most such organizations which were in operation were sheriff's departments or similar agencies located as far as 20 miles away.

Of 566 fatalities listed over a 10-year period at the places surveyed, the leading causes were swimming in unauthorized areas, inexperienced swimmers, lack of supervision among children, storms, and unsafe boats and equipment.

Among the survey's conclusions:

1. The Bureau of Reclamation itself lacks authority to enforce any ban on unauthorized and dangerous water activities.

2. Most State agencies have inadequate funds and personnel to enforce State water safety laws.

3. Long reservoir shorelines compound the problem of restricting swimming to authorized areas only. Because many visitors are from out-of-town or out-of-State, local education programs are not always the solution.

4. Major enforcement problems result from nonuniformity of boating laws.

The findings pointed the way toward new courses of action, and the safety councils, again with the full cooperation of other agencies, took appropriate steps. Water safety laws were enacted by State and local government bodies. Enforcement agencies were clearly identified and given power. More funds became available. Citizen response swelled, and both through government action and volunteer support, improved beaches, lifeguards, first aid stations, designated recreation areas, boating ramps and other facilities were provided.

Signs Posted

Mile upon mile of fencing and railings were erected, and gates were installed. Warning signs, sternly worded and often in two or more languages, were posted at key locations.

Facilities known as self-escape devices were provided. A provision that escape ladders be provided at 750-foot intervals in concrete-lined canals was written into the Bureau of Reclamation's general design standards. Ropes and floats, nets and safety screens were installed above siphons or other inlets to underground works or to outlet works located in populated areas. In areas of heavy wildlife population, ribbed devices which give secure footing for deer, antelope, and other game were placed because of concern for the welfare of four-footed animals.

The Bureau of Reclamation is currently in-

volved in converting open canals and drains to closed conduits, with immediate emphasis on those canals in urban areas. Reviewing this recent proposal, Commissioner of Reclamation Floyd E. Dominy noted that the cost of converting open channels to closed conduits varies according to the size of the channel.

"In some instances," he reported, "such costs have ranged from $200,000 to $500,000 per mile.

"But the benefits of social significance—the lives saved, the peace of mind of parents of small children, beauty enhancement and sanitation improvement, although difficult to evaluate, would fully justify the costs involved."

Whether making such large alterations, or the matter of imposing rules for boating on a small lake, it is obvious that conflicts sometimes develop. Experience indicates that it's a rare occasion when a proposal is given 100-percent support.

Speed Limits

Some time ago, for example, one of the councils recommended that safety regulations be enforced regarding motorboat speed limits, prohibited areas for fishing, swimming, and daylight hours for water skiing. A number of resort owners and operators objected, claiming that stringent rules and regulations would hinder the recreationist and hamper their own operation. But the council's State Legislative Committee worked with the resort operators, came up with a few simple but effective rules that accomplished the goals and smoothed the ruffled feathers.

On another occasion, a safety council enlisted members of a local boat club to write the safety rules for a major Reclamation reservoir whose operation had been transferred to a local group. The reservoir has as many as 16,000 boat launchings a year, and water safety had been a major problem. The boating and swimming rules were prepared and quickly implemented. Results? It was 6 years before the reservoir experienced a fatal boating accident.

Council officials past and present view the councils' representative membership—parents, businessmen, law enforcement officials, scout leaders, recreation enthusiasts, sporting goods suppliers—as major assistants in the success of the program.

But if this 10-year success has been emphatic and significant, it represents only a short advance along a long road. Thousands more Americans seek out water recreation areas each year, and for each and every one, there is need to warn of the dangers. Safety problems lurk in, around, and on every lake, stream, and pool in the Nation. The work of water safety councils has only begun. But a fitting word of advice from them could well be:

If you're going to have a drink of water, try not to take it accidentally. # # #

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW.
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON
(Except Southern wedge)
(Region 1)
Fairgrounds, Fairview Ave. & Orchard St.
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
P.O. Box 15011, 2929 Fulton Ave.
Sacramento, Calif. 95813

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (Sw tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

John Wesley Powell Centennial To Be in 1969

The vast Colorado River canyon country was unknown to man until John Wesley Powell in the summer of 1869 one-handedly led an expedition of 10 men and four boats down the wild waters of the Green and Colorado Rivers, from the Green River in Wyoming, to the mouth of the Virgin River in Nevada. A veteran of the Civil War who lost his right arm at the Battle of Shiloh, Powell wrote a report on the expedition, "Report on the Lands of the Arid Regions," which, according to Secretary Stewart L. Udall "showed clearly that water was the key to land use, and that shortages of water supplies demanded classifications of land for use and management."

Preliminary plans have been announced by three organizations influenced by Powell's vision—the Department of the Interior, the Smithsonian Institution, and the National Geographic Society—to stage a national centennial in 1969 of the explorer's heroic feat and to pay homage to a great American. Events would include a re-enactment of the 1869 river voyage, establishment of a John Wesley Powell Conservation Award, issuance of a commemorative postage stamp, and release of a motion picture depicting the Powell story for showing in classrooms throughout the Nation.

Powell died in 1902, the year in which the Reclamation Service, a direct result of his theories on water resources, was established as part of the Geological Survey. This agency became the independent Bureau of Reclamation in 1907.

NEWS BRIEFS

Bird's Eye View

Visitors to the Bureau of Reclamation's gian Glen Canyon Dam near Page, Ariz., are able t view 15,000 square miles of spectacular canyo country in northern Arizona and southern Utal as if from an airplane 50,000 feet above the earth

The panorama is featured in a three-dimensiona terrain model which represents more than 15,00 square miles of the drainage areas of the Colorad and San Juan Rivers above Glen Canyon Dam The model was completed in Denver and placed i the Glen Canyon Visitor Center.

NATIONAL WILDLIFE WEEK TO BE MARCH 17–23

"Learn To Live With Nature," the theme for National Wildlife Week, March 17–23, 1968, will focus emphasis on the importance of nationwide conservation education. It will provide a reminder that learning about conservation can begin with appreciating resource benefits such as clean air and water, scenic landscapes, and the Nation's rich wildlife heritage.

Attention also will be directed to conservation education as a meaningful way to protect natural resources by teaching that "wise use" will keep them in supply. Heading the annual observance this year will be Honorary Chairman Dick Van Dyke, television and motion picture star.

National Wildlife Week 1968 urges that conservation be made a part of local school programs and community projects. The concept of "learning to live with nature" means educating against pollution, waste, litter, and misuse of all natural resources.

Sponsored jointly by the NWF and its State affiliates, the observance has become an annual community event through the cooperation of State wildlife and conservation agencies, civic groups, and schoolchildren. This will be the 30th annual observance. It was first established by Presidential proclamation in 1938.

The Wildlife Week message points out past accomplishments of conservation. They include the rescue from extinction for the whooping crane buffalo and key deer, the soil conservation o prairie farmlands, and the continuing efforts t protect irreplaceable marshlands and other natura areas.

Wildlife Week materials are available from th National Wildlife Federation, Department 103 1412 16th Street NW., Washington, D.C. 20036

# # #

"Learn to Live with Nature," 1968 theme.

Cost Saving

Automatic controls that include computers and closed-circuit television are helping the Bureau of Reclamation to reduce the average expense of operating and maintaining its 49 powerplants despite rising wage rates and more costly materials.

The Bureau reports its average operation and maintenance costs have declined from $1.15 per installed kilowatt in fiscal year 1963 to only $1.05 in 1966, or over $600,000 a year.

Underground Sampler

A unique tool which enables soils scientists to remove soil samples virtually undisturbed from depths as great as 50 to 100 feet has been developed at the Bureau of Reclamation's Engineering and Research Center in Denver.

Known as a double-tube auger sampler, it consists of two steel barrels, one inside the other, with a cutting head and flights of augers on the outer barrel. It operates without need of air or water injection, which disturb the soil sample and make laboratory tests unreliable.

New Swift Dam in Montana Dedicated

The recently completed Swift Dam in western Montana, built by the Bureau of Reclamation in double-quick time after the disastrous 1964 floods had washed out the old Swift Dam, was dedicated last July 16.

The new Swift Dam is a graceful, nonsymmetrical, double curvature, thin arch structure on Birch Creek that depends for its strength on pressure against the solid rock canyon walls rather than on gravity. Only 22 feet thick at its base and 9 feet at its crest, it is 205 feet high and 573 feet long.

The old Swift Dam, built for the Pondera County Canal and Reservoir Co. over 50 years ago, was a rockfill gravity structure that collapsed when one of the worst floods in Montana history transformed Birch Creek from a shallow, 30-foot-wide stream into a roaring torrent half a mile wide.

The new structure symbolizes the great advances that have been made in the art and techniques of dam design and construction during the past half-century.

Huge "Tree Crusher" Aids in Phreatophyte Clearing

An 80-ton "tree crusher" was used in the recently completed first contract for clearing 9,500 acres of salt cedar and other phreatophytes—deep-rooted, water-loving growths—from the flood plain of the Pecos River Basin near Roswell, N. Mex.

The tree crusher is a self-propelled machine which fells, splinters, and crushes trees and undergrowth. The machine has a movable push bar at ground surface.

A serrated edge of the bar grips the phreatophytic growths sufficiently to uproot most of them. Large blade-studded steel rollers of the machine then splinter and compact the crushed plants into a compressed mat. Two of the 7-foot-diameter, 10-foot-long rollers, spaced 6 feet apart, are in front of the machine and a third roller of the same size is at the rear.

The Bureau's eradication of salt cedars and other phreatophytes is in a 150-mile-long area along the Pecos River from above Roswell, south to below Pecos, Tex., which will make available about 150,000 acre-feet of additional water per year.

The Pecos River Basin Water Salvage Office at Carlsbad was opened in February of last year to carry out a continuing program to reduce the nonbeneficial consumption of water in the basin, including that by salt cedar and other undesirable phreatophytes.

Oso Tunnel Drilling Crew Sets New Record

Using a giant earth boring machine called a "mole" the crew of Boyles Bros. Drilling Co. set a new single-day record for tunnel drilling when they excavated 403 feet of the Oso Tunnel on the Bureau of Reclamation's San Juan-Chama project on June 16, 1967.

The graveyard shift accounted for 116 feet of the total of 403 feet while the day shift advanced 143 feet and the swing shift climaxed the record-breaking effort with 144 feet. This exceeds the previous known record of 375 feet in 1 day and 132 feet per shift set in March 1967, on Blanco Tunnel on the same project with the same diameter. The 5.3-mile-long Oso Tunnel is being excavated to a diameter of 10 feet, 2 inches, through a formation of Lewis Shale.

The San Juan-Chama project is designed to make possible an average annual diversion of about 110,000 acre-feet of water from the upper tributaries of the San Juan River in the Colorado River Basin, through the Continental Divide, for utilization in the Rio Grande Basin, N. Mex. The imported waters will provide a full supply of irrigation water for 39,300 acres of land in the Rio Grande Basin, a supplemental supply for an additional 81,600 acres, and municipal water for the city of Albuquerque.

"Rivers in the Sky" Film Award

The Reclamation weather modification film entitled: "Rivers in the Sky" received a Golden Eagle Award last November. Given in recognition of high cinematic quality, the film also enabled "Rivers in the Sky" to be one of 157 American films competing in foreign film festivals during the summer of 1967.

Iowa State University To Study Irrigated Lands

Iowa State University will undertake a 5½-year research study for the Bureau of Reclamation to develop improved methods of evaluating the productive capacity of irrigated farmlands in the Western United States.

The research program will include field experiments, to be conducted cooperatively with other universities, at selected sites on Reclamation projects in the Western States.

The program is expected to develop better correlation between physical soil characteristics and crop yields under given conditions of irrigation in a wide range of geographic locations.

Improvements in land classification, crop responses, general production functions, economic returns, the capacity of irrigation developments to repay project costs, and more efficient use of water and land resources are expected to result from the studies.

Different crops and widely varying soils will be analyzed to develop data for use by the Bureau of Reclamation in planning and evaluating new irrigation projects.

The experimental sites will be selected jointly by Reclamation and Iowa State University, and progress under the contract with the university will be reported semiannually.

This study is expected to yield new concepts and methods that will improve Reclamation's procedures in land classification and economic analysis of irrigation projects.

U.S. GOVERNMENT PRINTING OFFICE: 1968 O—283-905

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6563	Missouri River Basin, S. Dak.	Nov. 24	Construction of stage 02 and 03 additions to Pierre substation.	A. G. Proctor Co., Inc., Aurora, Colo.	$282,918
DS-6564	Colorado River Storage, Colo.	Dec. 14	2 segregated-phase bus structures, 2 protective equipment assemblies, and 2 switchgear assemblies for generator units 1 and 2 for Morrow Point powerplant, Schedule 2.	Westinghouse Electric Corp., Denver, Colo.	278,382
DC-6566	Weber Basin, Utah	Dec. 6	Construction of Farmington equalizing reservoir for Davis aqueduct and West Farmington trunkline.	Miya Brothers Construction Co., Ogden, Utah.	277,433
DC-6569	Colorado River Storage, Colo.	Dec. 8	Construction of Midway substation, stage 01.	Ets-Hokin Corp., San Francisco, Calif.	510,042
DC-6570	Central Valley, Calif.	Dec. 1	Construction of 48.9 miles of pipelines for Westlands Water District distribution system for laterals 13, 15, and 17.	Hood Corp., Whittier, Calif.	4,244,595
DC-6571	Minidoka, Idaho	Oct. 16	Construction of additions to Minidoka 138-kv Interconnection substation.	C-L Electric Co., Pocatello, Idaho.	152,946
DC-6575	Central Utah, Utah	Dec. 1	Construction of 4-mile Water Hollow tunnel, with machine-bored tunnel section and 1 mile of channel No. 2, Strawberry aqueduct.	Boyles Brothers Drilling Co., and Gibbons & Reed Co., Salt Lake City, Utah.	5,594,828
DC-6577	do	do	Construction of 5 miles of Water Hollow access road and improvements for 9.7 miles of Currant Creek road.	Strong Co., Springville, Utah.	359,523
DS-6579	Missouri River Basin, Iowa.	Dec. 21	One 120,000/160,000/200,000-kva autotransformer for Denison substation, stage 04.	ASGEN-Ansaldo San Giorgio-Compagnia Generale S.p.A., Genova-Cornigliano, Italy.	180,000
DC-6580	Missouri River Basin, Mont.	Dec. 8	Foundation grouting of left abutment for Yellowtail dam	Eagle Construction Corp., Loveland, Colo.	964,950
DC-6584	Missouri River Basin, Wyo.	Dec. 15	Construction of Hanover pumping plant No. 5	Rognstad-Olsen Construction Co., Casper, Wyo.	200,320
DC-6587	Central Valley, Calif.	Dec. 1	Excavation for 6 exploratory tunnels and a shaft for Auburn dam.	Emil Anderson Construction Co., Ltd., Sacramento, Calif.	728,925
DC-6590	Columbia Basin, Wash.	Dec. 5	Initial excavation for forebay dam, including construction of cofferdam and bridge, for Grand Coulee 3d powerplant.	Green Construction Co., Des Moines, Iowa.	12,524,517
DC-6592	Missouri River Basin, Mont.	Dec. 1	Construction of auxiliary outlet works and spillway cofferdam for Tiber dam.	Foley Brothers, Inc., and Winston Brothers Co., St. Paul, Minn.	3,394,953
DC-6599	do	Nov. 27	Repairs and modification of spillway tunnel for Yellowtail dam. (Negotiated Contract.)	A & B Construction Co., and COP Construction Co., Helena, Mont.	483,810
100C-949	Columbia Basin, Wash.	Oct. 20	Construction of concrete lined Potholes canal, Sta. 1903+00 to 1908+00 and 1958+50 to 1966+40.	S & S Sand and Gravel, Inc., Ephrata, Wash.	109,580
100C-963	do	Dec. 5	Construction of 9.8 miles of buried pipe and 1.2 miles of open ditch drains, Block 82.	M & J, Inc., Moses Lake, Wash.	182,781
300C-252	Boulder Canyon, Calif.	Nov. 6	Construction of Coachella canal siphon barrel extension, Interstate Rte. 10 crossing, All American canal system.	B.W.B. Constructors, Inc., San Bernardino, Calif.	115,536
300C-266	Colorado River Front Work and Levee System, Calif.-Ariz.	Nov. 22	Clearing 357 acres and stockpiling riprap and gravel for channel levee and retention dike areas near Blythe, Calif.	Hunter Contracting Co., Gilbert, Ariz.	273,817

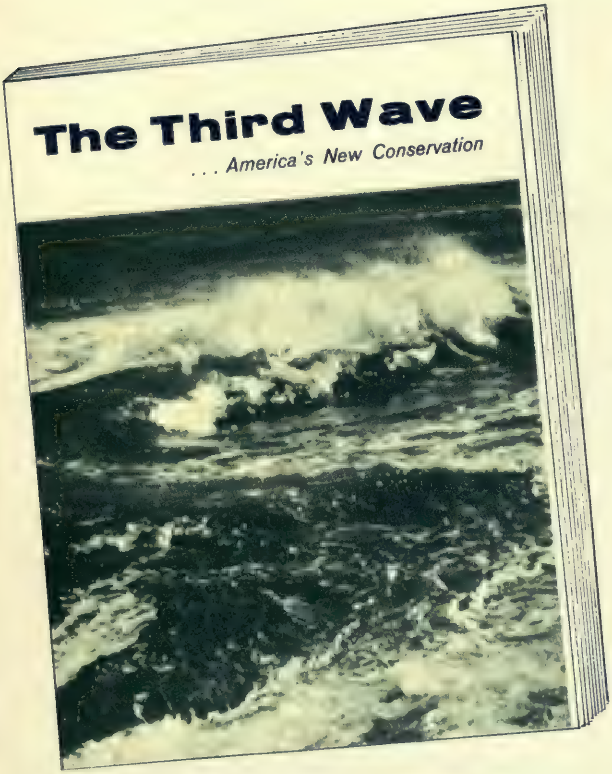
In its assigned function as the Nation's principal nature resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE



A Vital New Series for your Conservation Bookshelf ...

The U.S. Department of the Interior's CONSERVATION YEARBOOKS

CONSERVATION'S CONTINUING STORY

Man makes a third try on behalf of his world. The historic third wave of conservation, now gathering force in America, is the subject of the Department of the Interior's Conservation Yearbook No. 3. Pounding away at pollution, waste, and ugliness, this third wave seeks to restore our land and water, to protect our fish and wildlife, to conserve our fuel and mineral reserves. Three color photo essays and full-color illustrations throughout make this a beautiful as well as valuable, long-lasting source book for students, teachers, planners, and resource groups whose concern is for a quality environment.

THE THIRD WAVE
128 pages, 175 photos, 118 in full color . . . $2.00 a Copy

Still available . . . these two beautiful full-color companion Yearbooks

THE POPULATION CHALLENGE
80 pages, 85 photos, 38 in full color . . . $1.25 a copy

QUEST FOR QUALITY
96 pages, 209 photos, 72 in full color . . . $1 a copy

Send check or money order to: SUPERINTENDENT OF DOCUMENTS
U.S. Government Printing Office · Washington, D.C., 20402

May 1968

RECLAMATION era

A WATER REVIEW QUARTERLY

May 1968 · Vol. 54, No. 2

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 30 cents (single copy). Subscription price: $1.00 per year (25 cents additional for foreign mailing).

COMMISSIONER'S PAGE

WILDLIFE

Perpetuation and enhancement of wildlife an fishery resources has been a major national concern—bu more so now than ever before as our population expand and more leisure time is taken in outdoor activities.

A meaningful forward stride in the enhancement o wildlife came just 60 years ago. A reservoir area develope by the Bureau of Reclamation was utilized to establish th first Federal Wildlife refuge for waterfowl. This refug was on the Lower Klamath project in California an Oregon.

Subsequently, other Reclamation-developed area were used as refuges. Until today, more than 20 nationa refuges comprising more than 300,000 acres are operatin on Bureau lands and water acreage. In addition, more tha 40 reservoir areas, many including attractive recreatio features, are administered by State fish and game agencie

This is an increasingly important dividend of th Reclamation program. Although the stored waters a primarily for irrigation, hydropower, and other multip purposes, appealing man-made lakes in the country's ar zone are immediately appreciated for hunting, fishin and water-oriented recreation. Through recent legislatio the Bureau is authorized to develop projects to make th most of existing and potential fish and wildlife resource

As we mark the sixth decade of wildlife enhance ment on our projects, we point with pride to substantia benefits and accomplishments. Looking ahead we intend t continue cooperative planning and development effort with the related management agencies both Federal an State, and the result will be more enjoyable surrounding and the enhancement of valuable areas for our fish an wildlife neighbors.

Floyd E. Dominy

FLOYD E. DOMINY
Commissioner of Reclamatio

COVER PHOTO. Like "bombs away!"—trout fingerlings fall with a spray of water from low flying plane into Lake Powell below.

(Photo by Vern Jetley)

The lady has an empty barrel in carrying position. When filled with water for domestic use, the barrel is rolled to its destination. An irrigated field on the project is in the background.

AN AFRICAN river named Limpopo, meaning crocodile, is bordered by large fertile land areas suitable for expanded irrigation opportunities.

Instead of producing crocodiles in the Limpopo project area, the irrigated valley is a major producer of the same kinds of crops grown in the United States—rice, cotton, corn, wheat, tomatoes, and potatoes. Six to eight cuttings of alfalfa per year also are common.

Promise for LIMPOPO

by FLOYD E. DOMINY, COMMISSIONER OF RECLAMATION

Construction of the Limpopo project started in late 1963. Already Limpopo valley is the main agricultural "Show Place" of Mozambique, a Portuguese province in southeast Africa.

Like other progressive countries of the free world, which are taking action about providing important water developments for the future, efforts by the Government of Portugal will result in profitable expansion of the irrigated area of the Limpopo project from 77,000 acres to 160,000.

On invitation of Portugal, I was able to make a study-tour of the Limpopo project and other water developments in Africa last October. Accompanying me were Harold G. Arthur, Chief Designing Engineer of the Bureau of Reclamation from its Engineering headquarters in Denver, Colo., and J. Laginha Serafim, president of an engineering firm in Lisbon, who is an alumnus of the Bureau of Reclamation foreign trainee program.

Mozambique is bordered on the east by the Indian Ocean where the climate and land conditions affecting the Limpopo irrigation project make it similar to Reclamation's Central Valley project in California. The province is equal size to the combined States of Washington, Oregon and California, and has a total population of about 7 million, of which 97 percent are Africans. Major exports are agricultural products.

Intently going over designs for future water developments for the African nation are Mr. Serafim, left, who is a project designer from Lisbon; Commissioner Dominy, also in white shirt; and two local water officials.

Support 1,500 Families

Of Mozambique's large land and water resources available for agricultural development, the most significant will be utilized in the Limpopo project. Its 77,000 acres support 1,500 families. The families live together in groups or villages, each with its own European-style community facilities.

Also different from usual rural living customs in the United States, the 14 such villages are part of the government development and are located around the perimeter of the project area. Headquartered at Vila Trigo de Morais, is Manuel Teixeira Duarte, chief engineer of the project, and his staff.

Water service is from a major diversion dam on the Limpopo River flowing along the north side of the project. In addition to diverting project water into about a 30-mile-long main canal, the dam serves as a bridge over the river for both a highway and a railroad. A conventional system of secondary canals and laterals extend from the main canal to irrigate the project area by gravity.

Topped only by the Zambezi River, which is about 500 miles north in the same province of Mozambique, the Limpopo River is the second largest river in Africa emptying into the Indian Ocean. However, because of not having storage reservoirs, droughts in recent years have lowered flows below the amount needed either for full irrigation of the present project, or for the needed increase in acreage. In 1961, the river flow was only 25 percent of average, and in 1962–63 it had receded to 7 percent of average.

To solve these vagaries, construction will begin soon on Massingir Dam on Elephants River, an important tributary joining the Limpopo River about 25 miles upstream from the present project. This new dam will regulate the flow and provide the necessary carryover storage for more than doubling the size of the irrigated area.

Massingir's Design

Massingir Dam was designed by Mr. Serafim's consulting engineering firm from Lisbon. It will be an earthfill structure rising 120 feet above riverbed. Long dikes extending on the sides of the dam will make the total crest length over 2 miles, and its powerplant will have a capacity of 60,000 kilowatts. The bulk of its power generation will be marketed in the provincial capital, Lourenco Marques, 140 miles to the southeast. This modern seacoast city has a population of 200,000, making it the province's largest.

Early explorations along the 1,000-mile long Limpopo River make a story similar to some rivers in this country. It was first traced in 1869 and 1870 by foreign adventurers seeking a waterway to the sea from the Tati gold fields upstream. In modern times, Mozambique's transportation system is a vital asset to the shipment of products to and from several African Nations, particularly Rhodesia, in the interior. The province's seaports also are used considerably.

The reservoir created by Massingir Dam will extend 5 miles into Kruger National Park of South Africa as agreed by that Nation and Portugal. This will be a 2 million acre-foot reservoir about the size of a South Carolina reservoir named Lake Murray, or the reservoir behind Canyon Ferry Dam in Montana.

Cost $20 Million

Massingir Dam will cost about $15 million to build, and the powerplant and transmission lines will be an additional $5 million. A third of these costs will be repaid by revenues from the Limpopo project, one-third from the sale of power, and the other third from the proceeds of water for other lands and uses.

While industry has mainly been in processing agricultural products, another major dam and powerplant, soon to be under construction, is expected to expand industrialization in the important mineral resources area of the Zambezi River. This is the Cabora Bassa project north of Limpopo.

In Angola

Our review of the water and land resources on the west coast of Africa, in Angola, showed that this rain-belt province recognizes its great potential. In addition to its present developments, far reaching basinwide planning for multiple purpose water developments is underway.

In South Africa

The Department of Water Affairs of the Republic of South Africa gave us a review of their major water developments including their *dream* project of 40 years, the Orange River project. Now under construction on a river strikingly like the Colorado River in Western United States, is Hendrik Verwoerd Dam, the initial and key structure of the project. This 280-foot high concrete dam will be completed in 1971. Also planned for the next three decades in this great Orange River project are 2 other major dams, a 51½-mile long water tunnel, 20 hydropowerplants, thousands of miles of canals for irrigation, and power transmission networks throughout the country from the Atlantic to the Indian Oceans. # # #

Flows from the diversion dam on the Limpopo River formed an interesting sand bar which residents find useful.

Major exports from Mozambique to trading Nations are sugar, cotton, cashew nuts, copra (which is dried coconut meat yielding coconut oil), sisal (a strong durable white fiber from a sisal plant), and tea.

In the future, Mozambique will have larger exports and other dependable advances as its developments achieve greater usefulness of the valuable land and water resources.

DIRTLESS FARMING (*Hydroponics*) IN COLORADO

by NELLO CASSAI, Region 7 Information Officer

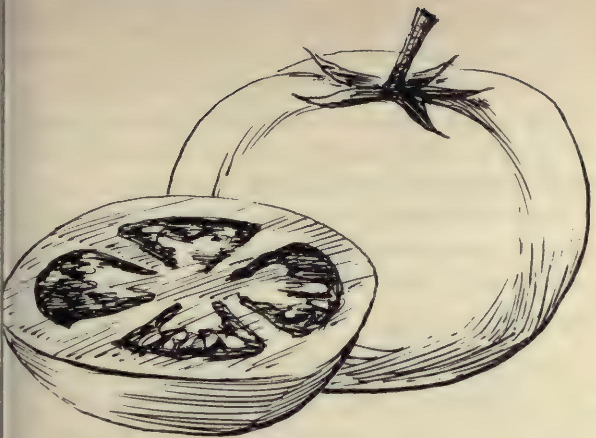
NEARBY they're fishing through the ice in a sharp wind off the Rockies and here's this fellow in a warm building picking ripe tomatoes from vigorous 8-foot vines.

An ex-Nebraska farmer, he is engaged in year-around gardening in Loveland, Colo.; and although he is using water from the Colorado-Big Thompson project, it is not in a manner envisioned by the men who designed the famous development more than 30 years ago.

Rollin F. Clark is a hydroponics farmer and he measures his operation in metered gallons of water, not headgate flow, and in square feet instead of acres.

Clark puts his delicious, vine-ripened tomatoes on the Colorado market in the dead of winter as well as other seasons. He get 35 cents a pound for all the tomatoes he can produce but he can't begin to keep up with demand.

Ripening fruit is abundant on tall vines.



There is nothing new about hydroponics—the rowing of plants in nutrient solutions—but it still ıystifies those who long have regarded the good arth as something sacred.

In hydroponics, the same chemical nutrients ound in good soil are dissolved in water and fed o plants or seed sprouts which are held in place y screens, sand, gravel or other material. Temerature and humidity are carefully controlled.

The rate of growth is startling. Barley "planted" n Monday may be 5 inches tall on Saturday. 'omato seedlings placed in Clark's greenhouses egin to produce marketable tomatoes in 2½ ıonths and continue to produce for another 3 ıonths.

Gaining Momentum

Although dirtless farming has long been estabished in other sections of the country, it was only bout 3 years ago that it made its appearance in 'olorado. And despite criticism and skepticism in ome quarters hydroponic operations are gaining ıomentum.

The Denver zoo produces from 700 to 1,000 ounds of barley grass daily, mostly as waterfowl eed. The U.S. Fish and Wildlife Service grows bout 1,800 pounds of barley grass a week at the Denver Federal Center as supplementary feed for eer and antelope kept for research purposes.

At Deer Trail, Colo., a dairy owner grows 1,000 ounds of barley grass daily to provide green feed or his herd of 40 cows.

The real emphasis in Colorado, however, is on ydroponic tomatoes and Mr. Clark is one of the ioneers.

He came to Colorado from a Lexington, Nebr., arm in 1965, developed a hobby interest in hydroponics and later formed the firm of Kelly-Clark, Inc., of Loveland.

Working full-time now, Clark not only produces tomatoes but he also sells a franchise package that includes equipment, plant nutrient, training at Loveland for the grower, supervision and advice on planting, growing, harvesting and marketing and advertising benefits from the firm's trade name tomato, "Gourmato."

So convincing has Clark's operation been that a Denver supermarket chain has gone into hydroponic tomato production in Loveland, with Clark as consultant.

Kelly-Clark has three greenhouses, made of translucent fiberglass and measuring 30 by 150 feet (4,500 square feet) each. Clark said 30,000 pounds of tomatoes are produced yearly in each building, from two crops.

23,200 Pounds

The average yield *per acre* (43,560 square feet) of field-grown tomatoes in the Loveland area is 23,200 pounds a year. (Each of Clark's greenhouses embraces a little over one-tenth of an acre.)

A fully-equipped building purchased from Kelly-Clark costs about $17,000, and Clark said a franchise owner with four buildings—the recommended number—can turn a tidy profit. He pointed out that the profit can fluctuate, of course, with the cost of labor, and stressed that a family operation is ideal.

Each greenhouse holds 1,600 plants, 11 inches apart.

Kelly-Clark franchises thus far have been set up near Boulder, Grand Junction and the Glenwood Springs-Rifle areas in Colorado. Clark also has shipped a building, with franchise, to oil-rich Kuwait on the Persian Gulf.

Clark is by no means exclusive in his hydroponic tomato operations in Colorado. There are a number of other individuals and firms in the business. And for good reason.

Better known for its skiing and trout fishing, the Colorado area has a comparatively short growing season and local vine-ripened tomatoes are available only for a limited period in late summer and early fall.

Flavor and Texture

"For the rest of the year we have been forced to rely on tomatoes from California or Mexico," Clark said. "They are packed green and allowed to

ripen during shipment or in storage at this end. The flavor or texture won't compare with a vine-ripened tomato.

"A hydroponic tomato tastes like one right out of the garden; in fact, it is right out of the garden."

Loveland residents, including Bureau of Reclamation employees who man the South Platte River projects office there, agree that the "Gourmato" sold in Loveland, and sometimes Fort Collins stores, not only look like a tomato but also smells and tastes like a tomato.

"And there are other factors which make hydroponic farming a good bet for the future," Clark continued. "As our population increases there will be a decrease in the amount of tillable land. Good farmland is giving way to huge shopping centers, subdivisions and highways.

"Equally important is the consideration of Colorado's vital water supplies, which are being stretched further every year."

Clark said each of his greenhouses weekly uses about 2,800 gallons of water, which with its nutrients is recirculated numerous times before it is discharged. The total of the three units, thus, would be 436,800 gallons a year.

Under average conditions it takes between 1½ and 2 acre-feet of irrigation water per acre to produce tomatoes in the field, according to a bulletin of the Agricultural Extension Service at Colorado State University. An acre-foot represents 325,850 gallons.

Multipurpose Water Project

Clark's water comes from the Loveland system, 1 of 11 municipalities served by the multipurpose Colorado-Big Thompson project—early showpiece of transbasin water diversion development.

Constructed by the Bureau of Reclamation over a 21-year-period (1938–59), it transfers water through the spine of the Continental Divide from the Pacific to the Atlantic watersheds.

It was designed primarily to provide supplemental irrigation water for 720,000 acres of rich farmlands in eastern Colorado and to produce electricity, but ever greater demands are being made by growing municipalities and industries.

Due in large part to the delivery of water and the ensuing urbanization, the assessed valuation in this, the Northern Colorado Water Conservancy District, climbed from $288 million in 1953, to $468 million in 1965 and to $493 million in 1966.

Total gross value of crops in the district was $97.3 million in 1966.

Over a long haul, the gross value of crops produced in the area from 1951 through 1966 totaled more than $1.2 billion—seven times the project construction cost of $162.7 million.

Principal crops are sugar beets, alfalfa, small grains, corn, vegetables and fruit. And important among the vegetables are field tomatoes.

Good Bartender

In discussing hydroponic tomato solutions, Clark is like a good bartender or chef in that he will publicly list ingredients but not quantities. He disclosed only that his nutrient formula contains such standard fertilizer grade chemicals as nitrogen, phosphate, potash and small amounts of trace elements.

Ralph Beede of Berthoud, Colo., gently fastens cord supports.

From vats in the center of a greenhouse, pumps with automatic timing devices force the nutrient-laden water to gravel beds holding the plants. In the beds are plants and pea gravel, nothing else.

When the pumps are cut off, after about 15 minutes, the water slowly returns to the vats by gravity from the sloping beds. This water is recirculated until the sodium content reaches a critical point.

Cord is gently tied around the stem of the small

plants and anchored to a wire 8 feet above the bed. Suckers are nipped as they appear, confining growth to the single main stem.

No smoking is allowed in the greenhouse. In fact, Clark won't hire a man who smokes, a precaution against tobacco mosaic—a deadly virus smokers may carry on their hands and transmit to tomato plants. Insect and fungus problems also are magnified in the near tropical climate of a greenhouse.

The tomato plants are pollinated merely by shaking the string on which they climb. When they reach a height of eight feet the plants are topped so that they may devote themselves to production of fruit instead of foliage and so that they don't shade out the valuable sunlight.

Seed types? Clark prefers three hybrids—loradel, manapal and tuck-cross, which are started in a separate building.

Its Detractors

As was noted earlier, the science of hydroponics is not without its detractors in Colorado and among them is Extension Horticulturist Charles M. Drage of Fort Collins.

"I'm acquainted with a number of these units and I haven't found one that is practical, considering the costs and risks involved," Drage said. "I handled over 80 consultations last year with people interested in hydroponic tomatoes and I suggested to them that there might be a more efficient way to grow greenhouse crops."

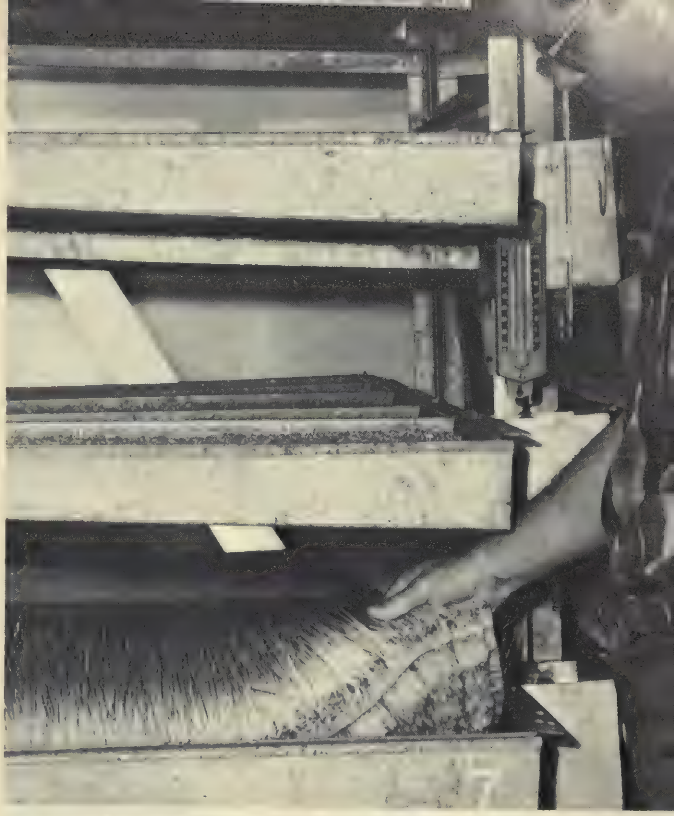
Drage explained that, in his opinion, the old-fashioned greenhouse is a better answer to those seeking to market tomatoes in the off-seasons.

He cited a circular (Hoagland and Arnon) issued by the College of Agriculture, University of California at Berkeley, which states in part:

"Water requirement is no less in nutriculture . . . Tomatoes grown side by side in soil and in water culture in the same greenhouse afforded an opportunity to measure the relative amounts of water utilized. The number of gallons of water used to produce 100 pounds of fruit were as follows: soil, 222; water culture, 257 . . . The nutritional quality of the products was the same. The two could not be consistently distinguished in a test of flavor and general quality. No significant difference could be found in the content of vitamins."

Clark didn't want to enter the conventional greenhouse-versus-hydroponics debate, but said that most of the hothouse tomatoes he has eaten apparently were shipped green "because they simply haven't had the flavor."

"Although I get no encouragement from Fort Collins, scores of other land-grant colleges and universities in the country are keenly interested in my operations. I am conducting numerous seed tests for them and constantly exchanging other information," Clark said.



Wildlife biologist Ed Knittle examines barley grass grown in automatic operation at the Denver Federal Center, Colo.

Deer eat the dirtless grass, roots, paper lining and all. These animals and antelope are kept for research purposes by the Fish and Wildlife Service.

Kansas State U.

Kansas State University at Manhattan works actively with hydroponics and has even held clinics for greenhouse tomato growers.

Dr. Gary Paulsen, nutritional researcher, KSU Agronomy Department, has summed up his views as follows:

"Nutrient culture (hydroponics) for commercial production is practical only when the soil, climate, or other factors give it an economic advantage over conventional means of plant production.

"In indoor installations, such as greenhouses, use of nutrient cultures is often preferred to use of soil. Advantages of nutrient culture over soil culture include greater uniformity of plant growth, greater control of nutrient supply, and pH (acidity), decreased incidence of plant diseases, and the potential for automation of production.

"Not all these advantages may be realized at the same time, however, and they may not offset the disadvantages associated with nutrient culture.

"Among these disadvantages are high cost of facilities, limited area of production, increased severity of plant diseases, and the need for considerable technical knowledge to manage installations."

In barley production, the buildings are windowless metal units with artificial lighting. The seeds are soaked and then placed in metal trays lined with perforated paper placed on a screen to hold the sprouted seeds. Temperature and humidity also are carefully controlled for this crop.

In the U.S. Fish and Wildlife operation in Denver, 4 pounds of seeds produce 30 pounds of grass in five days. The entire mat of thickly grown roots, grass and paper is removed from the tray for feeding and the tray is immediately replanted.

The grass, high in protein, is considered an excellent nutritional aid and cuts the animals' consumption of grain and alfalfa. But like indoor tomato growing, the dirtless way still mystifies the man with the high regard for the good earth.

# # #

For Dams

"Electrocardiographs"

Do Inside Job

Sensitive to any new pressure . . .

A treasury of information

AS A DOCTOR uses his electrocardiograph to examine the heart of the human body, the hearts of dams built by the Bureau of Reclamation are carefully examined by electrical instruments for the same reason—to find symptoms which may need attention.

Like the medical specialist, "House calls" by Reclamation "doctors" have increasing benefits because of improved instruments for dam inspection.

In fact, like reports of medical advancements, considerable value is placed on Reclamation's advances in the water resources development field. Such reports are extensively utilized by other designers and builders of dams in many nations.

One of the more recently developed examining instruments—used like an electrocardiograph—is the strain meter. The sensitive section of this in-

strument when unmounted, resembles a large electric etching pen with a long power cord dangling from one end. When mounted for service and embedment in wet concrete, the other end is fastened to about 11 other strain meters forming a star shaped cluster.

These meter clusters perform difficult inside jobs. They are installed at selected locations deep in a dam in the freshly placed concrete at the time of construction. They are forever inaccessible after the concrete sets, but remain sensitive to any change in pressure. The electric cords extending from all strain meters, are marked individually so

they may be immediately identified on their respective gauges at the inspection terminal located in a gallery or other accessible location.

Structural Performance

Technicians take meter readings at these terminals as part of the dam's surveillance program to evaluate performance of the concrete throughout the dam. The effort enables correction to keep the structure from developing major problems.

Another instrument, important for evaluating behavior of Reclamation dams, has been success-

Above. This man is placing a strain meter (which performs like an "electrocardiograph") in position in wet concrete.

Right. Some strain meters are in Morrow Point Dam, shown near completion on the Gunnison River, Colo.

292-242 O - 68 - 2

ful without exception in the six decades of the agency's inspection experience. It is a surveying instrument, known as a theodolite.

To many people, a similar surveying instrument known as a transit is familiar atop a tripod used for locating exact corners of plots of land such as city lots. In checking a dam with the more accurate theodolite, which is set up at permanent marks on the ground near the dam, its crosshairs are lined up on tiny target marks, located at many points on the crest and other exterior surfaces of the dam.

Surveys make it possible to determine whether and how much the dam has settled, or shifted in any way. Using this precise theodolite, it also is possible to detect structural deformations in the large interior galleries of dams.

A significant chapter in extending safety and economy to the construction of dams was the the Stevenson Creek Test Dam built in southern California in 1926.

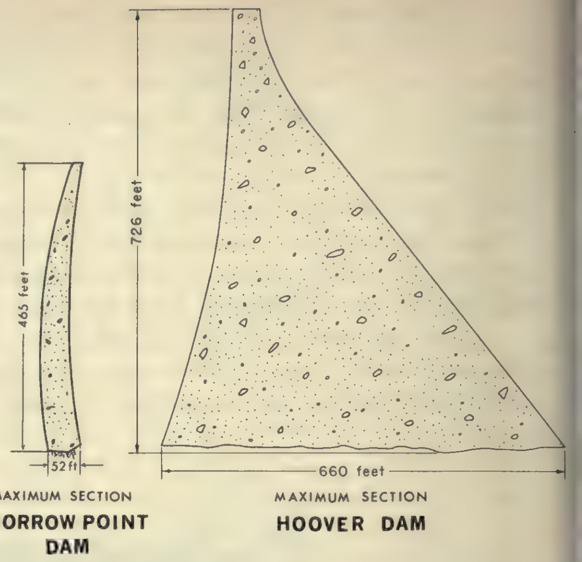
Ideas Developed

Numerous instruments and ideas were included in that dam. The test structure was a newly designed thinarch type, constructed with the economical and versatile portland cement concrete. Effects of generation and dissipation of heat, resulting from chemical reaction of portland cement and water, were analyzed. Methods were developed for cooling concrete during construction, and for minimizing increasing temperatures.

Many trial instruments were embedded in the concrete during construction of this dam to measure movement, strains, and deformations. The effects of varying pressures on the dam due to the rapidly filling and emptying reservoir were measured.

The first major structure, which the Bureau of Reclamation undertook after participation in the test work at Stevenson Creek Dam, was Hoover Dam on the Arizona-Nevada boundary—started in 1931. About 500 of the most useful measuring instruments, like those used in the test dam, were embedded in Hoover during its construction. A veritable treasury of valuable behavior information has been gathered from responses of the meters in Hoover Dam, from readings taken both during construction and since completion.

Information from instruments has become increasingly useful during the existence of Hoover Dam. A limited number of strain meters were



Comparison of design and amount of concrete are shown in profile views of two dams. Pressure exerted from reservoir would be at left.

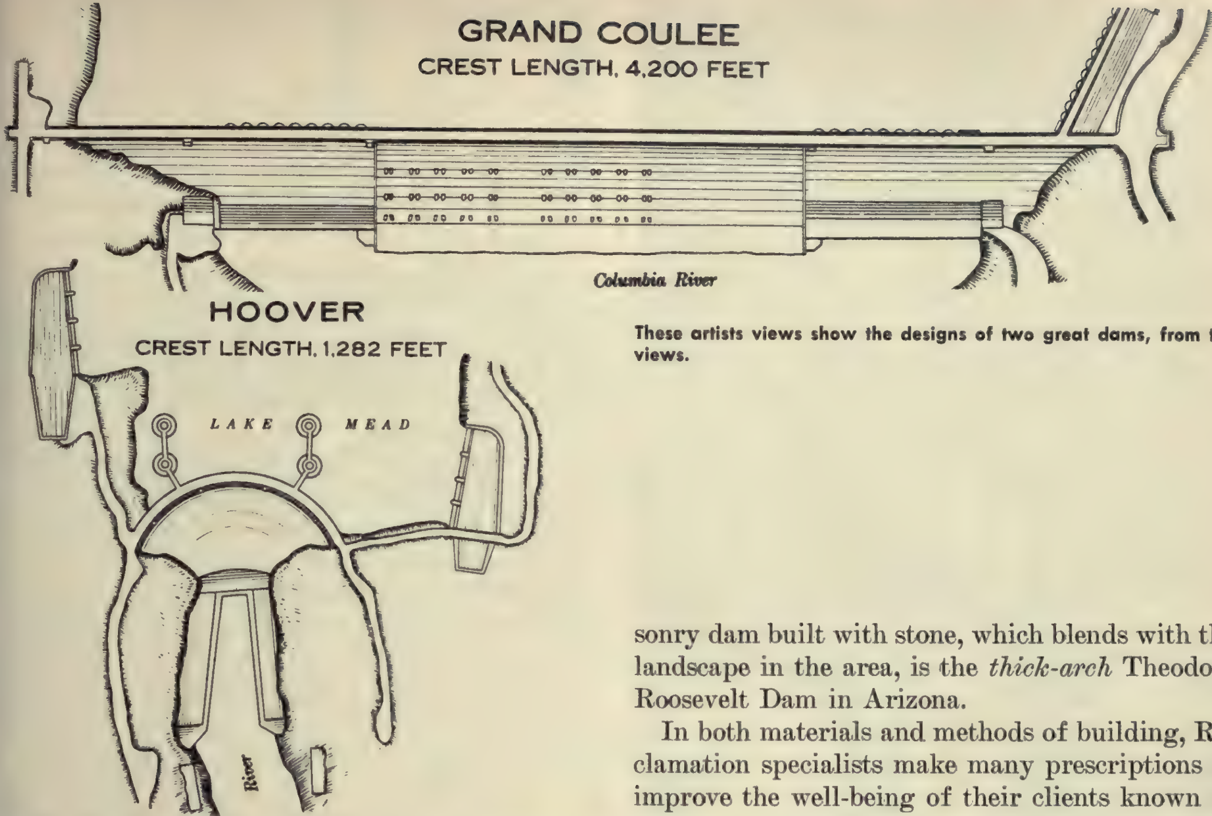
strategically placed in Grand Coulee and Shasta Dams in Washington and California, respectively. Results confirmed Reclamation's design experience on those structures, and gave increased confidence for new designs which has meant saving millions of dollars in use of concrete without sacrificing effectiveness.

Similar instrumentation is used in earthen dams to accomplish high standards of performance.

Recent Solution

A problem relating to the voluminous information furnished by the new pace-setting instruments has been solved since the early 1950's. Prior to that time, readings from the various meters required computations by desk calculating machines demanding extensive manpower and time to make the information fully useful. But with the coming of high-speed computers, the design engineer can utilize the technical data sooner and more beneficially. New concepts for improved structures—which might not have been achieved for 30 years or more, before the advent of computers—can now be initiated with full confidence plus multiplied effectiveness in as little as three years. The computer has been a great boon to water resource developments.

The strength and the amount of concrete needed in a dam depends on design—whether it will be vertically *curved*, horizontally *arched*, or simply



These artists views show the designs of two great dams, from top views.

straight. For use at some sites for dams, a savings of millions of dollars can be realized by building the thin-arch dam needing less concrete with more, or no loss of, strength.

The drawings with this article show comparisons of the sections of several dams and an idea of the relative amounts of concrete needed to build them. The design of Grand Coulee Dam is the *straight* type which derives its great water holding power from the heavy downward force of gravity, or weight of the structure.

Graceful Lines

Although its graceful lines are only partly visible, Hoover Dam is called a *thick-arch* and it required a comparatively large quantity of concrete. Recently completed Morrow Point Dam in Colorado, on the other hand, has even more artful lines, and a tremendous amount of concrete was saved through its *thin-arch double-curvature* design. Glen Canyon Dam in Arizona as an *arch* design, saved much expense for concrete, and is widely known for its beauty. Before the extensive use of concrete, the masonry-arch Pathfinder Dam in Wyoming, built in 1909, was constructed of indigenous stone quarried near the site. Another masonry dam built with stone, which blends with the landscape in the area, is the *thick-arch* Theodore Roosevelt Dam in Arizona.

In both materials and methods of building, Reclamation specialists make many prescriptions to improve the well-being of their clients known as dams, and related structures in the field of water resource developments—and the medical profession is not the only one, nowadays, which uses the delicate electrocardiograph. # # #

Superhighway for Kilowatts

Public and private electrical systems in 11 Western States will be linked by the Nation's largest single electrical transmission development with completion of the Pacific Northwest-Pacific Southwest Intertie, now under construction.

The Bureau of Reclamation says the intertie will transmit 4,600 megawatts of power over two direct-current, extra-high-voltage (750 kv) lines, first of their kind in the Nation and the longest in the world; two alternating-current (500 kv) lines; and a system of shorter lines. The EHV lines will originate near The Dalles Dam in Oregon and terminate at substations near Los Angeles and near Hoover Dam in Nevada.

The intertie will permit marketing of surplus peaking capacity and surpluses of secondary energy and exchanges of power and energy between the Northwest and the Southwest.

The balloon will be 600 feet high when filled with helium.

IDEA "HOME" for BALLOON TESTS

A giant polyethylene balloon tugged gently, but firmly, at the truck that held it earthbound on the runway, and the transparent bag stretched like a crosswise cloud 600 feet tall above the airport at Page, Ariz. Launching crews made last minute checks of the balloon's helium content.

They gave a final examination of the telescope and remote-control radio system in the gondola. Late afternoon shadows already covered Glen Canyon Dam, 2 miles away. To the east, on this March day, the last of the day's sunshine transformed a length of red sandstone into a horizon of frozen fire along the shore of a shining Lake Powell.

This was the scenic desert setting, and technically favorable climate for the Polariscope launching last year. It was only a short distance from the successful launchings of the huge altitude-studying balloons starting about 5 years ago in the depths of the canyon between towering, perpendicular, sandstone walls of the Colorado River. At that time, the balloon made a silent ascension from a stationary clamp.

On the airport runway, however, the balloon was to be launched as perfectly vertical as possible, matching the force of any light wind by driving the truck downwind at a speed equal to the breeze. The balloon was quickly released from the jaws of a steel clamp on the truck, which was halted at the instant it was seen that the balloon stood vertical. Then like a trained tiger, the gondola leaped away, rising swiftly.

To 22 Miles

Within an hour, the balloon reached 60,000 feet. In 2 more hours it climbed to its float height of 120,000 feet—more than 22 miles above its adopted home on a Bureau of Reclamation water resources development project.

The 15-hour flight of the Polariscope had several purposes: To study the planet Mars, vibration, polarization of light in ultra-violet rays and various other atmospheric effects.

The tests are by the National Center for Atmospheric Research. In recent years, many such flights have been made from Page, Ariz., by the NCAR in cooperation with programs of the University of Arizona, Louisiana State University, Jet Propulsion Laboratory, Massachusetts Institute of Technology, and the University of California at San Diego.

The gadget-packed gondola was brought down by parachute at noon the day after it was launched. Although the return package landed in a tree many miles south of the launching site, and there was damage to the sensitive instruments, it was a successful mission.

The NCAR plans to install permanent facilities at Page, because the weather is favorable for launchings 3 days out of 5, as compared to about 1 of 5 at other locations. # # #

A Fisherman looks at Reservoirs

by CHARLES E. MOST

The trees on the western bluffs had stretched fingerlike shadows almost to the other side of the reservoir when a fast-moving outboard rounded the point and abruptly slowed down to approach the floating dock.

The lone man cut the motor and deftly guided the boat into the slip. After making fast to a cleat, he placed a large tackle box and his rod and reel on the dock. He then lifted a stringer of fish and stepped from the boat onto the wooden walkway.

His weathered features showed he had spent many hours outdoors and his eyes had the look that comes from seeing things at a distance.

However, a young man on the dock ignored the boatman's features; he was looking at five big bass on the stringer. Forgetting his angling manners, he blurted, "Where and how did you catch fish like that?"

"You might say I caught them in the lake," the older man curtly replied.

John, the young man, caught the rebuff and explained, "I've been fishing here for a week and all I've caught were a few bluegills; why your smallest fish is almost four pounds and I couldn't guess what the big one weighs."

The fisherman, recalling similar experiences when he was younger, softened, "Yes, the smallest one will go around four and I think the big one may top seven pounds. Sorry to hear about your bad luck. What part of the lake were you fishing?"

John related his fishing activities of the past week, describing just where he had concentrated his efforts. As the two men continued to chat about various fishing experiences, the rapport that always seems to exist among sport fishermen became apparent.

Meet Me Here

Finally the older man said, "My name is Bert and if you would like to meet me here tomorrow morning about sunup, we'll see if we can stir up some action."

The morning sun had burned the last traces of mist from the surface of the manmade lake when Bert shut off the motor and let the boat coast in toward a snag standing in the water 50 feet out from a rocky bluff.

"Tie the boat to that snag, John," he directed, rigging up John's rod with a small sinking lure. "Now cast right up against the rocks and retrieve very slowly." John made the cast and cranked the lure back to the boat. "That's not what I call slow," Bert said. "Try it again—only this time, I want you to feel that lure bounce from ledge to ledge as it sinks toward the bottom."

John made a second cast and slowly dragged the lure off a ledge, stopping the retrieve to let it sink until he felt it bump the next ledge. When the lure was about 10 feet down, a dark shape detached itself from the shadow of a huge boulder. With slowly moving fins, the fish followed the lure for a few feet and then struck savagely. John felt the strike, set the hook, and after a few hectic moments of keeping the fish away from the spectrallike submerged trees, boated a nice bass.

John was elated as he put the fish on the stringer.

"How did you know the fish would be so deep, and in this particular spot," he asked.

Cold Blooded

"Well, we've had several weeks of hot weather and it's warmed up the water," Bert explained. "Fish are cold-blooded animals and their body takes on the temperature of their surroundings. The deeper water is cooler so the fish go deeper to get more comfortable. Also these sunken trees attract smaller fish allowing the bass to pick up a meal here without too much trouble. The jumbled boulders make this place even more attractive because they provide cover from any enemies the bass may have.

"What more could a fish want? Here he has a comfortable home, protection from enemies, and a supermarket just outside the front door. Fish aren't really so different from people when it comes to getting along in the world," Bert concluded.

The two fishermen managed to take three more bass from the base of the cliff before Bert announced that it was time to move on to another spot. He seemed to know the best places and John commented on this.

Bert shrugged, "Since I retired 3 years ago, I've been spending every summer here. It took me several weeks to find some of the most productive spots and I still locate new ones from time to time. A reservoir is a lot harder to read than a stream. Most fishermen can look at a stream and tell where the fish are likely to be, but a big lake is tougher. There's so much of it to learn."

Then Bert grew more pensive, "There aren't as many good fishing streams now as there used to be and most of the ones that are left are overcrowded.

"It's pretty obvious that with the population growth and the numbers of fishermen increasing, more people are going to turn to reservoirs for their sport. The other day, I was talking to one of the fishery biologists conducting research on this lake and he told me that because of reservoirs, there is now more fishing water in the United States than at any time in history. He also said that over one-third of America's anglers fish in reservoirs."

You Showed Me

"Why are they doing research on this lake?" John wanted to know. "My success wasn't too good until you showed me where to fish, but that was ignorance, not a shortage of good fish to catch."

"For one thing," Bert replied, "This is a relatively new lake. They want to compare it with older lakes where fishing has started to decline. A lot of reservoirs provide great fishing during their early years but then it drops off. These biologists want to know why the fishing declines."

As blazing July sun reached its zenith, Bert suggested finding a shady spot for lunch and a "siesta."

When they had finished eating, Bert leaned back against a large rock and said, "Might as well relax a while. We would probably pick up a fish or two but it will be better later on."

"Why?" John asked.

"Big fish are pretty wary," Bert replied, "and they seem to know that their greatest danger is during the brightest hours of the day. Those biologists I was telling you about have found that fish populations are usually nearer the surface during the night."

"How do they find out things like that—with a crystal ball?"

"They have special equipment. For example, they can locate fish with a sonar-type instrument, similar to those developed to locate enemy submarines during the war.

Finding Comfort

"Water temperature would certainly affect fishing in a lake," John ventured. "You said earlier that fish go deeper to find a more comfortable temperature during hot weather. The average water temperature could determine the kind of fish in a reservoir because a cold water fish such as trout could not live in a warm water lake."

"That's true except where a lake has the cold water for trout in deeper areas and warmer water

near the surface for bass. There are a number of lakes like that in the United States.

"The biologists aren't limiting their studies just to the kind of fish you and I like to catch. They're also studying what they call forage species—the little fish that big ones eat, and also nongame fish.

"They even found 'sleeping' fish on the bottom during some of the night studies. This may be an important factor in night fishing for bass."

"Judging from the fight the fish gave us this morning, I don't think I could land one at night unless it was asleep," John laughed.

"These fish are in fighting trim. They grow very fast in this lake."

A splashing sound broke the afternoon stillness, interrupting Bert's remarks. A short distance up the shore from where the two men were sitting was a rocky point that jutted into the water. A large fish had swirled on the near side of the point where a small feeder stream entered the lake.

"Say, that's a good fish," Bert said. "It acted like it was chasing minnows. I suppose the cool water from the brook has attracted the little fish. There he is again. That fish is asking to be caught and I think we should accommodate him. The fishing ought to be picking up about now anyway."

Bert stepped over to the boat and extracted a battered rod case from under the front seat. He removed a fine old fly rod from the case and quickly joined the sections together. Next he took a fly reel from the depths of the big tackle box, mounted it on the rod, stripped off about 20 feet of line and threaded it through the guides.

"That's the first fly rod I've seen since I came here," John remarked.

Prefer Fly Rod

"I prefer to fish with a fly rod," Bert replied, "But it's not as versatile on reservoirs as some other methods. For one thing, you can't fish deeply with it as easily as with other types of tackle. I keep this rod in the boat just in case I run into a lucky situation like this. That fish is after minnows in shallow water and this streamer fly should imitate a minnow enough to do the trick."

Bert asked John to use the paddle to position the boat for the cast. "Don't bump the side of the boat," he cautioned, "fish are easily frightened when they're in shallow water."

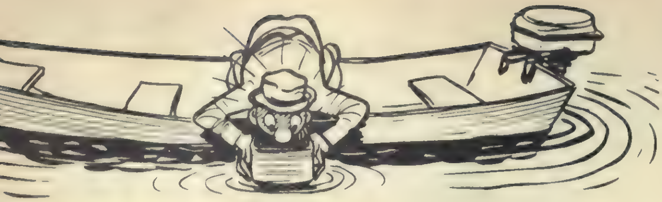
When the boat was about 40 feet from where they had seen the fish, Bert tossed the line into the air, false cast once and dropped the fly right at the mouth of the little stream. The minnows scattered wildly as the fly landed. Bert was just starting the retrieve when a large bass surged into the shallows, grabbed the fly, leaped once and then turned for deeper water. The reel screeched in protest as the fish bored for the shelter of some rocks along the point. Bert felt the leader grate against the sharp rocks and then the line went slack. The fish was gone but Bert had a happy grin on his face. "If I won all the battles, I'd give up fishing," he said, summing up his philosophy that sport fishing is for fun and not just for food.

The two men changed places in the boat and Bert started the motor, heading the boat back up the lake. They passed several spots that looked good to John but when he pointed them out, Bert only shook his head.

Finally after cruising for several miles, Bert turned the boat into a broad cove and cut the motor.

Good Place

"This is a good place to fish late in the day," he said. "This cove is pretty shallow. You can tell that by looking at the banks. They are low and the gentle slope continues right on under the water. A steep bank usually indicates deep water near shore. Big bass will move into a shallow area



like this in the evening and at night because there are usually plenty of small fish, frogs and other things they can eat. Last year this cove was dry by the end of summer due to the demand for more water farther downstream."

"Does that sort of thing happen often?"

"No, it doesn't. There was little rain last year to help maintain water levels, but the people controlling the dams have been very cooperative. Federal agencies like the Bureau of Reclamation, Tennessee Valley Authority, and the Army's Corps of Engineers, as well as private power companies, want to provide the best possible fishing in reservoirs under their jurisdiction.

"As the biologists learn more about reservoir fish they will probably come up with some management recommendations. State game and fish departments and the reservoir construction agencies will play the major role during this management phase.

"According to the needs of a particular lake, reservoir agencies might be able to coordinate drawdowns with fish spawning seasons. This could control nongame fish such as carp or help maintain good conditions when game fish are spawning. Drawdowns can also be used to control unwanted water plants and to help clear up muddy lakes.

"The work that's done on a reservoir site before the lake is filled can also have considerable influence on future fishing. It wasn't many years ago that construction agencies cut every tree in a reservoir area, right up to the high water mark. Cleared areas in deeper water are important for boating, water skiing, swimming, and commercial fishing, but leaving trees in shallow areas is also important.

Trees Help

"These trees hold down wave action and this helps to prevent shore erosion and roiling of the water. Timbered areas also provide good cover for many kinds of fish. White bass, for example, prefer open water areas but most fresh water fish like trees, rocks and other kinds of cover.

"The biologist told me two other ways that flooded timber can help fishing in reservoirs. These submerged trees go through a slow rotting process that releases carbon dioxide into the water. Apparently sediment is held in suspension by an electrical charge. The carbon dioxide helps to neutralize the electricity and the tiny particles settle to the bottom. This helps keep the water clear. Also, standing timber, and the twigs, bark and other forest litter in the water promotes the growth of microscopic organisms. These tiny plants and animals are eaten by larger creatures, which are in turn eaten by aquatic insects and small fish which then feed larger fish and so on. This is called a food chain and all of it is affected when one link is weak.

"The reservoir construction agencies are generally in favor of leaving trees in many parts of a reservoir because it's good management and it reduces construction costs."

Seen the Dam?

"Have you driven down for a look at the dam since you came here," Bert asked.

"Yes. It sure took plenty of cement to build one that big."

"Notice anything of particular interest to fishermen?"

"Well, the river below the dam certainly looks nice. The water is really clear. Any fish in it?"

"That river is one of the top trout fishing places in the country."

"How could that be? This is a warm-water lake."

Bert laughed. "Remember earlier when we were talking about the deeper water being colder? The water that runs the turbines in the powerhouse at the dam comes from deep down in the lake. The temperature hardly changes between winter and summer and it's just right for trout. I hear it's still cold enough for them thirty miles downstream.

"Streams just below dams are called tailwaters and they usually fluctuate quite a bit because of power plant operation, irrigation needs downstream and for other operating reasons. Because of these fluctuating water levels, trout normally don't spawn in such areas. The Federal Government has built National Fish Hatcheries at a number of these dams and they've really paid off. Tailwaters are rich in food and trout stocked in them usually grow very fast. Because of the fast water tailwater trout are well conditioned fish and they really give you a fight. Trout weighing more than

15 pounds have been caught in the river below here."

"Fifteen pounds," John exclaimed. "I didn't know trout grew that large in civilized waters. I'd like to fish that stream."

"If you do, I'd suggest you use a boat. The water can come up pretty fast when power releases are made from the dam and there is some risk when wading."

No Strike Yet

The two fishermen had been casting and retrieving various lures through the shallow cove, but neither had had a strike. Suddenly, John saw a fish take something from the surface near an old decaying stump. He pointed it out to Bert who told him to try and bounce the floating lure off the stump so it would appear that some small animal had jumped or fallen into the water. John made a near perfect cast, bouncing the lure into the water about 3 feet from where they had seen the fish. "Let it lay there for as long as you can stand it and then give the lure a light twitch," Bert instructed. John watched the motionless lure for about 30 seconds; then his nerves got the best of him and he gave the rod a slight jerk.

Although both anglers had anticipated the strike, they were both startled when it came. A big bass hit the lure so hard that John almost lost his grip on the rod. "Don't let him get into that brush," Bert yelled, frantically backing the boat toward deeper water. The big fish tore across the shallow cove, alternating long runs with crashing leaps. John hung on grimly as the bass threw his weight and power against the drag of the reel. "Don't horse him now," Bert cautioned as the fish began to show signs of tiring. "Try to keep him away from the boat until he's thoroughly played out."

The big fish stubbornly circled the boat, but his strength was just about gone. Finally the fight was over and John eased the fish in toward Bert who had picked up the landing net. Bert held the net under the water until the fish was over it and then lifted him into the boat.

John started moving toward the rear of the boat and Bert had to tell him to sit down before the boat capsized. Bert then reached into the net and got a grip on the fish's lower lip, a hold that keeps bass from wiggling too much. He handed the fish to John and the awe-stricken look on the young man's face was ample reward for the old angler's advice. "I think he'll weigh around 8 pounds, John," he said quietly, trying not to break the spell.

The Thrill

As John began to recover from the thrill of catching the largest fish of the day, he started talking about the battle. Bert interjected comments of his own for a few minutes and then cranked up the outboard and made the long run back to the boat dock.

John took the large bass over to the boat dock operator's weighing station while Bert unloaded the boat, then filled and lit his pipe. The slap of waves created by the boat's wake had died down.

He mused over the day's fishing and the thoughts and ideas he had passed on to the young fisherman. The shortage of fine fishing streams was to be regretted and Bert was sure the growing human population would create even more demands on America's fishing waters.

With reservoirs expected to absorb a large part of this increased fishing pressure, Bert knew that the keys to proper reservoir fishery management, geared to individual reservoirs or regions, would have to be found. He was glad the search was already underway.

With a last look at the lake, Bert turned to join John at the weighing station. He hoped the big bass was heavier than eight pounds. # # #

ABOUT THE AUTHOR. *When he wrote this interesting story on fishing in reservoirs (the article here is condensed for the* Reclamation Era *from pamphlet form), Charles E. Most was employed with the Bureau of Sports Fisheries and Wildlife of the Department of the Interior. He was an Information specialist in Washington, D.C., before moving to his present position as Assistant to the State Director of the Bureau of Land Management for Montana.*

Orchard Trend on the Columbia Basin Project

Growing

Cherries, Prunes, Peaches, Pears and Plums

Spring spreads her magic over the fertile lands of the Columbia River Basin, Wash. Nowhere is this truer than on the Royal Slope area where the landscape colors run the gamut from the deep green of winter wheat to the pale lace green of carrot tops.

To complete the spell delicate petals in shades of the palest pink to deep rose burst forth in a number of orchards on the Slope.

One of these orchards, is operated by Kay Newell and her mother, Mrs. L. C. Keylon. This orchard, which is just reaching the productive age, was the dream of Kay's father, L. C. Keylon, a veteran developer of new orchards in the Yakima area.

It was 1961 when Mr. Keylon decided to select a piece of land on the Columbia Basin project on which to start a soft fruit orchard. After a careful study of the Royal Slope area, considering such things as air drainage and soil—key elements in a successful fruit operation—Mr. Keylon concluded that farm unit 263 in Block 87, of the Bureau of Reclamation project area, was the land he wanted. The next step was to purchase the unit and the Keylon-Newell Orchard was fact.

Mr. Keylon's daughter, Kay, a corporation tax consultant at the time, came from California to work with her father. Shortly after the farm was purchased, however, Mr. Keylon died. Kay and her mother, determined to carry out the man's wishes, developed the orchard according to his plans. They now have approximately 90 acres planted to cherries, prunes, peaches, pears, and plums.

First Plantings in 1962

First plantings of some of each fruit were made in 1962, and other plantings followed each year since. The first harvest was from the peaches which produced fruit in just 2 years.

Cherry trees planted at 40-foot intervals cover approximately 50 acres. Miss Newell says that in 1966 they sold their first cherries on June 9 and picked the last of their crop 2 weeks later when other orchardists were just beginning to pick. Early ripening is a prime consideration as the early fruit nearly always commands a higher price on the market. Miss Newell credits ideal location and soil, which her orchard possesses, for the early maturity of her fruit.

Interplanted with cherries are early Italian prunes. Long-range plans are that in 15 or 20 years, when the cherry trees have reached full growth, the prune trees will be removed. In the meantime, the approximately 40 acres of the Keylon-Newell orchard are the largest concentration of prunes on the Columbia Basin project.

The orchard has about 20 acres of pears, mostly Bartlett, and some Anjou. There are also 10 acres of President plums. The President plum is a large dark plum which draws a premium price on the New York market. According to Kay Newell, Mr. Keylon was the first to introduce this variety to the Yakima Valley.

The ranch is maintained with part-time help and the full time services of a superintendent, Harry Idell. He and his wife live on the ranch year round.

The operation and lightened work of the winter months gives Miss Newell and her mother an opportunity to vacation in the South. They have a home near San Diego, Calif., where they usually spend the time between Thanksgiving and Easter.

The Keylon-Newell Orchard is only one of several young orchards now producing soft fruit or apples on the Royal Slope and each year the acreage increases. This has been the trend through-

ay Newell stands amid flowering peach trees in her orchard on
oyal Slope, Wash.

ut the Columbia Basin project. According to the 966 crop census, a total of 1,836 acres were devoted o fruit production. Among the delicious northern arieties reported were apples, apricots, berries, herries, grapes, peaches, pears, plums, and prunes.

\nother Orchard

Zane Newton, whose farm in the Columbia Basin ?roject's Irrigation Block 79 has 41 acres of young ruit trees. Newton has come up with a solution o the difficult pruning problem which all orhardists face. Knowing he must establish a scienific pruning program for his trees if his young rchard operation is to succeed, Newton began earching for a way to overcome the high costs and carcity of skilled pruners, which cost about $20 n acre in the project area.

Being a man of imagination and mechanical kill, Newton surveyed his farm for equipment nd set about converting several machines that ormally lie idle most of the winter. In his farm hop, Newton completed a pruning machine that an be operated from the farm tractor.

The dual purpose piece of equipment is used oth for topping the trees and for hedging the ides. Its cutting bar can be adjusted to top anyvhere between 6 and 13 feet, and hydraulic lifts hange the verticle angle of the sickle for hedging he sides of trees. The sickle bar moves at the rate of 800 strokes per minute, giving a smooth clean cut to the tree branches.

Basically, the machine is made up of a 9-foot sickle bar from the hay mowing machine which is powered by a three-horsepower chain driven gasoline motor from the farm roto-tiller. Three hundred pounds of tractor wheel weights are used as a counterbalance to offset side thrust of the cycle bar. These parts were assembled on an iron framework costing $40 for materials—the only cash outlay for the entire project.

Attaches To Tractor

When needed, the whole machine is attached to the tractor—a job which can be done in less than an hour. Since none of the equipment used in the machine will be needed until summer, pruning and hedging which are usually done in the winter do not interfere with other work.

Newton now has 21 acres of pears and 20 acres of apples which are planted in 20-foot row spacings. He says the apple trees in the hedge row planting will be topped at 8½ feet and the pears at 10½ feet. According to Newton, it is hard to make an estimate of the savings which will result from using the new machine in lieu of hand pruning, but he expects them to be considerable even though some hand pruning will be necessary to properly shape the trees.

Both the apple and pear orchards are young and just beginning to bear fruit, but this progressive grower-inventor feels that it is important to start training the trees early. He believes that if topping and hedging are begun when the trees are young, it is possible to control height and width indefinitely. This, of course, means decreased production costs over the years as labor and equipment costs for followup pruning and harvesting are lower for smaller trees.

Newton seems to have found an answer to one of the basin orchardist's most pressing problems, but he is not stopping there. Now he is turning his thoughts to developing some type of picking platform equipment that will reduce the labor costs for harvesting fruit.

This kind of spirt is common on the Columbia Basin project where progressive, efficient young farmers don't sit back and wait for somebody else to do it, but get busy and find their own solutions, even if it means building a brand new machine.

\# # #

*Nestmakers in Kansas—
a Reclamation flood control
and irrigation project becomes
a home for waterfowl.*

KIRWIN—Where Birds Came to Stay

by NAOMI L. HUNT, Washington, D.C.

Farsighted people, back in the 1930's, envisioned the possibilities of reclaiming flood and drought-ravaged lands of north-central Kansas. Conservation was planned for land, water, and wildlife—through flood protection, water shortage and irrigation. Also in 1952, the Kirwin Unit, Solomon Division of the Bureau of Reclamation's Missouri River Basin project was started.

Kansas lands, watered by Kirwin Reservoir, are highly productive now, and a wide variety of field crops is replacing "soil bank" crops and surplus wheat production. Corn, grain, sorghum, and alfalfa hay flourish on this once arid land.

Today, 3,650 acres of land receive water directly from canals and 7,850 acres are served by lateral branches. The Kirwin National Wildlife Management Area, under the Fish and Wildlife Service, includes reservoir water surface and 10,684 acres of adjacent land.

Old-time conservationists say that 30 years ago, wildfowl were seldom seen nesting in this area. Prolonged droughts and soil-eroding floods had caused a decline in agriculture and natural cover. There was little to attract migratory flocks. However, in nature nothing is so constant as change, and when a more suitable environment was developed, a greater abundance of waterfowl resulted.

Nesting Sites

In a number of years before the Kirwin Reservoir was built, it was found that artificial nesting sites on manmade lakes could successfully replace lost natural sites. Mated pairs of waterfowl, with wings clipped, nested in unlikely locations. Propagated birds attracted wild birds on their northward flight, and new flocks, bounded by instinct to the place of their hatching, returned to perfor the rites of spring amid unusual surroundings.

Wildlife managers first experimented with art ficial islands of dirt near the shoreline and bird nested on them. Metal frames, wire netting, an other kinds of barricades were used to keep awa foxes, raccoons, and skunks. Later, "crib islands of huge logs were piled up on the ice during winte When the ice melted in spring, the logs floated o the water and offered nesting places, safe from th "long arms" of predators.

The Canada goose will choose a nesting site onl if it affords a 360° angle of vision for at least quarter of a mile. For this reason, parent bird have found "boxes" placed high above water i isolated trees to be safe nesting sites.

Mallard Nests

Wild mallards, normally ground nesters, wi use open or well-lighted nests on or near wate and will also use elevated, boxlike nests in place where artificially propagated birds have bee released.

Honkers will nest in washtubs, in treetop plat forms, and even in old tractor tires. When one ob serves the unusual, inconvenient, and dangerou sites sometimes chosen by nesting birds to conduc their family affairs, it appears that almost an facility, however crude, might serve as an induce ment to nesting.

The Kirwin Reservoir offers an unequaled op portunity for waterfowl management. Tens o thousands of birds visit the area each year, includ ing such rare species as the whooping crane, white fronted goose, and white pelican. Rolling prairi lands and croplands surrounding the reservoir pro vide excellent habitat for prairie chicken, pheas ant, and bobwhite quail.

In Dead Trees

Last year, to increase nesting sites for expanding flocks of geese at Kirwin Refuge, nine platforms of baled-hay were placed in dead cottonwood trees left standing when the lake filled. Five of these platforms were used by nesting geese. A wild mallard laid a clutch of nine eggs in an old goose's nest. Even more surprising, it was reported that five blue heron nests and five cormorant nests were built in that same tree, and the parent birds were busily incubating their eggs.

More and more frequently, tiny woodies, greenheads, and honkers tumble from "artificial" nests placed where no natural sites or cover formerly existed. Shoreline vegetation provides protection from inclement weather and predators. Planting and encouraging suitable aquatic plants such as buttonbush, spatterdock, and certain rushes helps supply a variety of insects and seeds for feeding. Loafing sites of anchored rafts and protruding logs further enhance the appeal of this manmade lake for nesting waterfowl.

The attractive total environment maintained at Kirwin Reservoir is resulting in a home for thriving broods of waterfowl species never before known to nest in that area—an invitation for them to stay. # # #

Diversified maternity tree used by several geese, a mallard, five herons and five cormorants.

Drownings Reduce But More Safety is Needed

What has been done about the tragic drownings at water areas where people seek recreational pleasures?

Results of campaigns for water safety over a 5-year period are significant—

For each one-million visitor days at water resource facilities operated by the Bureau of Reclamation in 1961, there were three drownings.

In 1966, only 0.9 people drowned per one million visitor-days.

This is a significant reduction, especially in view of both the booming use of lakes by recreationists and the increasing availability of such bodies of water. Unquestionably, much credit for the improvement results directly from stepped-up safety efforts.

(A visitor-day is defined as a significant time span spent by a visitor during a 24-hour day.)

Although the improvement shows Operation Westwide as succeeding, there are still problems, and the effort to curb drownings is continuing.

Operation Westwide is a plan for supplying ideas, leadership and programs in an attack on the drowning problems. Launched jointly by the Bureau of Reclamation and the American Red Cross in 1957, Reclamation's water safety efforts since that time steadily increased. This includes the construction of several kinds of physical barriers and devices to prevent drownings and aid in rescues around many of its structures. It also includes helping to set up education programs enlisting individual and community support.

The 10 years of effort of this Federal agency in the program is described in an article entitled: "On Purpose—A Better Way to Take Water" in the February 1968 issue of *Reclamation Era*.

(*Continued on page 49*)

Two close down: Centers in Lewiston, Calif. and McCook, Nebr.

7 Conservation Centers Keep Going

by CHRISTOPHER W. IVUSIC, Washington, D.C.

It was 3 years ago this spring that the Bureau of Reclamation opened its first Job Corps Conservation Centers in California, Colorado and Wyoming. Hundreds of youths, many from the crowded Eastern cities, arrived in Casper, Wyo.; Lewiston and Toyon, Calif.; and Collbran, Colo., to begin the work and training that would give them their "great second chance."

Of these first four Conservation Centers activated in April and May of 1965, one, the Lewiston Center, is now closed due to a cutback in antipoverty funds. The McCook, Nebr., Conservation Center also was shut down last March and put into "mothball" status. But the young men have not been retired, or put away for future use. They have been assigned to other Conservation Centers, where they may continue to learn a trade that will help them find a worthwhile job.

(This effort is now called the Civilian Conservation Center program.)

Like the enrollees themselves, the Bureau's Job Corps Centers are still young. Later this year four more will reach their third birthdays: Arbuckle, in Oklahoma; Columbia Basin in Washington; Marsing in Idaho; and Weber Basin in Utah.

The staff at each of these facilities is improving day-by-day in its knowledge and capability of handling the Nation's school dropouts, society's potential troublemakers and turning them into productive citizens.

As one Job Corps leader said, "Don't underestimate the ability of these kids. They want status. The trouble is no one has ever considered them important enough."

Another, expressing a feeling of fairness and equality that is found in the very core of American life: "It is not at all uncommon to see a young Caucasian man from the deep hills of Tennessee patiently teaching a young Negro lad from the Bronx the art of tying a fly."

The chance to work and live in the great outdoors! Many young men thrill over the West's vastness, beauty, and opportunity. Many youths, however, had not the money to buy a ticket, nor the language or reading ability to find their way West before joining the Job Corps.

These youths are repaying their benefactor for the chance to find a new life in the land of the big sky. The conservation, recreation, and community service projects they have completed or are now working on are worth millions of dollars to the Federal, State, and local governments, whose citizens now have the opportunity to enjoy camping and lakeside facilities built by Job Corps.

By now, probably most people know how the Job Corps program works, of how it takes school dropouts from the ages of 16 to 21 and gives them the equivalent of an eighth grade education while teaching them a useful trade. These trades are their tickets to a better life. But not many Americans are aware of how the Job Corpsman himself works.

Arbuckle, Okla.

At the Arbuckle Center, under the direction of Leroy Anderson, Job Corps youths have learned carpentry, welding, custodial maintenance, landscaping, heavy equipment operation, truck driving, and automotive mechanics. They have a good reading program, with the library in Sulphur at their disposal. Their math program has 13 steps, and their "World of Work" program, used at other Centers, teaches them about jobs and salaries and other vocational factors.

Many at Arbuckle Center have passed the State of Oklahoma's driver examinations, and scores trained to fight forest fires. The area in which they live and work is a friendly one, and citizens of Sulphur and the Job Corpsmen have a mutual respect and confidence. With their knowledge of vo-

Signs for areas near a Reclamation reservoir are being completed here by two youths and Supervisor J. R. Norton at Arbuckle.

cational skills, they have built and assembled hundreds of useful facilities for the recreation and conservation enhancement of Platt National Park and Lake of the Arbuckles.

Casper, Wyo.

In Casper, Wyo., Job Corpsmen started from scratch to learn the use of hand tools, axes, shovels, picks, saws, and then progressed to the use of machinery, from concrete mixer to power shovel, in order to develop the recreation and conservation improvements at Cottonwood Recreation Area at Alcova Lake.

Local and county officials, who are to operate the recreation area, value the Job Corps work at $250,000. The Casper Job Corps youths planted 16,000 potted Ponderosa trees around Alcova, Seminoe, Kortes, and Glendo Reservoir areas, with an additional 25,000 seedlings due to be planted each spring for the next several years. They have aided the Bureau of Land Management, another Federal agency, by clearing fire breaks in mountain forest, and developing springs for livestock.

In April 1967 Casper Job Corpsmen were stranded in a blizzard in Lusk, Wyo. Instead of standing by idly, they volunteered to shovel streets in the business district, and earned the gratitude of the town officials.

The Corpsmen have been held together by an excellent staff, directed by John D. Anderson, selected for its keen interest in youth. In Casper, a Citizens Community Council was organized in July 1966 to maintain close communications and relations between the community and the Job Corps Center.

Collbran, Colo.

At the Collbran Center, directed by Paul Kirt Carpenter, Corpsmen have built a trail for the blind near Independence Pass in Colorado; and a Nature Trail in the Grand Mesa-Uncompahgre National Forest. When youths first went "out in the field" after reporting to the Center in May 1965 they had to learn how to use chainsaws and axes in order to clear the area surrounding Vega Reservoir of many dead aspen trees.

Since, then, Collbran enrollees have become skillful in building a campground for Cottonwood Reservoir No. 1, Grand Mesa, on the Collbran project; performing beautification work along the 50-year-old Highline Canal on the Grand Valley project; and cleaning up the muck and debris following the flooding of irrigation canals on the Paonia project and of the town of Lamar, Colo. Many of the youths at this center have been trained as firefighters, and some have taken a course in wilderness survival, which has taught them rescue operations.

Carpentry on their own recreation facilities is underway here by Weber Basin Corpsmen, from left, Kenneth Ingersoll and Curtis Alfred.

Columbia Basin, Wash.

At the Columbia Basin Center, which unlike the other centers has not been dedicated, Corpsmen have concentrated their conservation and recreation work on developing trails, camps sites, and boating facilities at Potholes Reservoir, Banks Lake, Soda Lake, and Soap Lake on the Columbia Basin project; and in the area of O'Sullivan Dam and in Coulee Dam National Recreation Area.

Over 100 youths, trained in fire suppression, saw action in three Washington forest fires during 1967. The center held its first open house in February 1967, and Director Benjamin Pease and the 184 Corpsmen welcomed visitors from as far away as Henry, Nebr.

Besides their reading and math programs, the Columbia Basin youths have found time to set up basketball and football programs, as well as learning trades such as heavy equipment operation, cooking, general maintenance, painting, concrete laying and form setting, truck operation, television repair, and land management and utilization services.

Marsing, Idaho

The Job Corps Center at Marsing, Idaho, has developed a recreation complex at Lake Lowell, Boise project, that antipoverty officials term "a show window which few Job Corps Centers have." But Corpsmen are also extremely proud of their newspaper, "The Snake River News," which won awards at the Idaho State High School Press Association convention in April 1967.

Marsing Job Corpsmen also are proud of one of their graduates, a Montana youth named Gerald T. Greeno, Jr., who was the only youth from a Department of the Interior-run Job Corps Center selected to receive a $1,000 scholarship to work and study in Washington, D.C.

Since their first Christmas in Marsing, when Corpsmen serenaded several homes in Marsing with Christmas carols, the youths have cultivated a cooperative, healthy attitude to their community neighbors, and have proven that "stopping poverty from spreading from father to son, from mother to daughter" is certainly not a wasteful effort. This center is under the direction of Cleve Bolingbroke.

The youths have earned the respect of the area's citizens by taking part in a search effort for a lost girl, fighting area forest fires, and volunteering to help with the aged and handicapped at a Marsing nursing home.

Toyon, Calif.

At the Toyon, California Center, youths alternate with 1 week of schooling, and 1 of work, as at other centers. They have used their acquired skills to build a nature trail on Whiskeytown Lake, a trail near Brandy Creek, and the Judge Francis Carr Memorial at Whiskeytown Lake, Central Valley project. Center Director Granville W. Tilghman says this conservation work is worth some $215,000. Youths have put in over 4,000 man-hours of fighting fires, planted 40,000 trees, and cleaned up Shasta Union Cemetery and the community cemetery at Redding, their "home" community.

Blood donated by Corpsmen to the Toyon Job Corps blood bank has been used to treat leukemia and to aid members of the Veterans of World War I in Redding. Last October (1967) over 400 youths from Toyon and the now defunct Lewiston Centers took part in a massive search for 3 persons lost in the rugged mountain terrain of Trinity County following the crash of their light plane.

Weber Basin, Utah

The last of the Bureau's Conservation Centers to be activated, and one which already has significant achievements, is the Weber Basin Center in Utah, near Ogden. Youths there under the direction of Richard A. Ulrich completed much valuable conservation and recreation work on the

Weber Basin project, particularly around Willard Bay and Causey Reservoirs. The Center held an open house last December to take note of their 2 years of active operations.

Marked by a staff that demands strict discipline and an abiding respect for property among the Job Corps youths, the Center bested 50 other Conservation Centers throughout the United States with its safety record of having nearly 3 million man-hours of work performed without any lost time. The record won the Center the Department of the Interior's Certificate of Safety Achievement.

Corpsmen themselves, at Weber, won the distinction of being above average nationally in their length of stay at the Center, averaging 6.7 months. They have fought forest fires in Utah and Idaho forests; torn down old, unused houses in Layton, Utah, which will save taxpayers about $5,000; and in their sign shop at the Center have made over 400 signs for recreation areas.

For a number of community service projects at Christmas time and other times during the year, and for maintaining good community relations, the Council of Ogden City, Utah last January passed a resolution commending and congratulating "all those concerned with the Weber Basin Job Corps for providing a new future for some of the underprivileged youth of America." # # #

Drownings Reduce *(Continued from Page 45)*

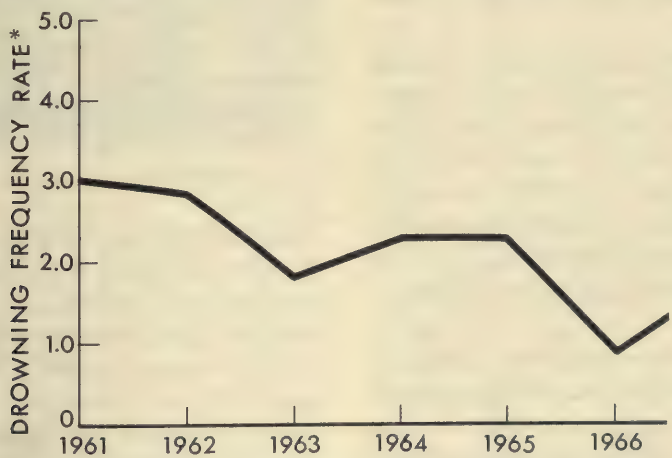
Out of Trend

Although the accompanying chart is helpful in noting a general downward trend of drownings, it is seen that the rate rose in 1964 and 1965. Correction of the rise for the future may require the important application of more public support in certain areas.

The figures were made available from water based recreation facilities which the Bureau of Reclamation built, and are being operated either by Reclamation, State or county governments, or irrigation and water districts. The figures do not include the Reclamation facilities operated for recreational purposes by other agencies of the Federal Government such as the National Park Service or the Forest Service.

Safety programs also are particularly active around canals, the effects of which are not shown above nor in the graph, because they are generally not recreation areas. Persons are not usually supposed to visit or make use of canals for recreation purposes, and no visitor-days are recorded for them. However, the general trend is a reduction in canal drownings from what it was seven years ago: 44 in 1961; 38 in 1962; 29 in 1963; 31 in 1964; 35 in 1965; 27 in 1966; and 24 in 1967.

In both reserviors and canals for 1967, there were 13 drownings on Reclamation facilities operated by irrigation and water districts, 19 on facilities operated by Reclamation, and 37 under State or county operation. Of this total 69 occurrences, 21 were due to swimming accidents, 20 by falling, 13 by boaters, none by fishermen—which is usually the lowest group, but this is the first total zero since at least 1962—and 15 from other water related activities. # # #



Drowning frequency rate is the number of drownings which occur for each 1 million visitor-days in the water recreational area.

Out of the Blue . . .

FLYING FISH

by **W. L. (BUD) RUSHO,**
Region 4 Information Officer

Being a fish in these modern times can get to be pretty exciting—like being flown for a thousand miles or so across the mountains and then being suddenly ejected without a parachute into a strange canyon lake that didn't even exist a year or two earlier.

In the stodgy old days of fish history, a young fingerling could at most count on a tank truck ride, winding up by being gently eased into a lake from along the shore. But that was before the Bureau of Reclamation started putting mammoth reservoirs into inaccessible canyons that hardly anyone had ever seen before. There simply weren't any roads to get fish-bearing trucks to the shorelines.

The answer, of course, was air drops. Once in a while, a fingerling can still manage to get aboard a truck. But more and more the trend is to the massive drops (1 million fish each trip) from low-flying planes.

Trout and Bass

Lake Powell, the serpentine blue lake that winds about 170 miles up the Colorado River from Glen Canyon Dam, has received most of the fish so far. Both rainbow trout and large-mouth black bass have been dropped into the lake repeatedly since 1963, totaling some 12 million trout and 5 million bass. Kamloop trout, kokanee salmon, and black crappie have also been planted in limited numbers as an experiment.

Navajo Lake, which lies across the Colorado-New Mexico border above the Navajo Dam, received 714,000 large-mouth black bass in the spring of 1967.

One of the longest flights was made from the Bureau of Sport Fisheries and Wildlife's fish hatchery at Uvalde, Tex., to Willard Reservoir in northern Utah. About 800,000 bass were carried on this occasion in 1966. Willard Reservoir is the new fresh water lake carved from an arm of the Great Salt Lake to supply irrigation water to lands of the Weber Basin project.

The first fish dropped into Lake Powell were

lucky. No predator fish were waiting for them as they plunged into the rising waters. Since then, both the bass and the trout in the lake have grown tremendously—reaching 7 pounds in the case of one rainbow trout. The bass, however, are the predators.

The pilot of the plane dropping fish these days must take care to be over deep water before giving the drop signal. When the fingerling trout hit the warm surface water they will instinctively dive to cooler depths, which also gets them away from the hungry bass.

Tasty Guests

If an error is made and the fish are planted in shallow water, the fingerlings merely become tasty tidbits for the bass. Bass are also cannibalistic, finding their own kind as tasty as the young trout.

As an experiment, the Bureau of Sport Fisheries and Wildlife planted some 6-inch trout in Lake Powell last fall, in the hope that the larger trout can compete more successfully with the bass. (Normally, 2 inches is the planting size.) Recent tests on Lake Mojave, below Hoover Dam, proved that 6-inch trout can withstand being dropped from a plane.

The shock of the violent transplanting apparently wears off rapidly, for the fish find plenty of food in the new lakes and rapidly grow into healthy, adult fish.

For many of them, there is to be one final traumatic experience—that of grabbing the wrong piece of food and finding a hook in it. Another violent transplant, this time into a frying pan.

But after all, like the gingerbread man in Aesop's fable, what is a fish for except to eat?—from the human point of view, that is. # # #

WATER SURPRISES Thai Village

While exploring subsurface conditions for the giant Pa Mong project in Southeast Asia, a joint Bureau of Reclamation-Thailand drilling crew has inadvertently brought in an artesian well, thereby providing the surprised villagers of Ban Nong Waeng in northeastern Thailand with a welcome supply of clear, pure water for their local "Wat," or temple.

The drill team made its "unimportant" find over a year ago and then moved on, still investigating foundation materials instead of natural fountains.

Recently Mr. Jesd Liongsuthisakon, a Thai geologist working with the Pa Mong USBR project returned to the scene and reported that the villagers had piped the water by gravity to the village and to the Wat, using hollow bamboo as pipe for a conveyance system. The villagers requested that the drill hole not be plugged.

Above. **Hollow bamboo pipe carrying water to the temple is shown above the heads of the two men. At right. A fellow can take a refreshing drink at this junction in the pipe.**

Mr. Jesd went the villagers one better and recommended to the U.S. Operations Mission in Thailand that they make a small expenditure for pipe and technical assistance to further improve the windfall water supply and the villagers' impromptu delivery system.

The new Ban Nong Waeng water supply is a good small-scale deal, involving a dependable flow of 20 liters a minute—about 5,000 gallons a day.

But the proposed Pa Mong project is immense. It involves the multiple purpose development of the Mekong River, one of the largest in the world, with an average annual discharge of about 400 million acre-feet of water annually. The project envisions development of some 5 million acres of irrigable lands and the production of 20 billion kilowatt-hours of electricity per year at the Pa Mong damsite alone.

Although the 20 liters of water a minute is no match for the development of the vast supplies of the Mekong River, it means something to the villagers of Ban Nong Waeng. JDW

Biggest Earth-Moving Project

Biggest earth-moving project in the history of the Bureau of Reclamation is the San Luis Canal, a part of the massive Central Valley project in California. This 123-mile-long canal involves the excavation of 57 million cubic yards of earth and rock—the equivalent of a trench 16½ feet wide and 10 feet deep stretching from Denver to Boston. When completed, the canal will form one of the largest "manmade rivers" in America.

Also on the Central Valley project, Contra Loma Dam was completed and a banquet held celebrating also the 30th anniversary of the start of construction on Reclamation's CVP.

The Contra Loma Dam will be used to provide greater dependability for the Contra Costa Canal system which supplies water to the Pittsburgh-Antioch area. Water from the canal will be pumped into the reservoir to provide an alternate source of supply should anything go wrong with the system between the intake to the canal and the Antioch area.

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW.
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Fairgrounds, Fairview Ave. & Orchard St.
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
P.O. Box 15011, 2929 Fulton Ave.
Sacramento, Calif. 95813

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (Sw tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has ırried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form ay be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

AIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. DOCS.

Enclosed find $_____________ (check, money order, or Documents coupons). Please enter my ıbscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1 a year; 25 cents addi ɔnal for foreign mailing.

Name____

Address______________________________________

City, State, and ZIP Code___________________________

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Materials	Contractor's Name and Address	Contract Amount
DS-6564	Colorado River Storage, Colo.	Feb. 12	1 isolated-phase bus structure, two 1,000-kva station-service transformers, and one station service switchgear assembly for generator units 1 and 2 at Morrow Point powerplant, Schedule 1.	Brown Boveri Corp., North Brunswick, N.J.	$139,310
DS-6582	Columbia Basin Wash.	Jan. 19	12 solid-state and 7 miscellaneous relay cabinet assemblies and 1 lot of transfer trip tone equipment for 230-kv consolidated switchyard, Grand Coulee third powerplant.	Westinghouse Electric Corp., Denver, Colo.	196,888
DC-6585	Chief Joseph Dam, Wash.	Jan. 8	Construction of Toats Coulee Creek diversion dam and 6.5 miles of Sinlahekin Creek siphon.	A&B Construction Co., Helena, Mont.	1,205,781
DS-6588	Columbia Basin, Wash.	...do.....	Furnishing only, 2 armature windings for generator units at Grand Coulee powerplant.	Allis-Chalmers, York, Pa.....	337,492
DS-6591	Pacific Northwest-Pacific Southwest Intertie, Ariz.	Mar. 1	Parts and materials for uprating existing 230-kv oil circuit breakers at Hoover powerplant, Metropolitan Water District switchyard. (Negotiated Contract.)	Westinghouse Electric Corp., Denver, Colo.	239,845
DC-6595	Southern Nevada Water, Nev.	Mar. 26	Construction of River Mountains tunnel, with machine-bored tunnel section, and outlet portal structure.	Utah Construction & Mining Co., San Francisco, Calif.	3,946,619
DS-6597	Columbia Basin, Wash.	Feb. 21	Architectural design of Grand Coulee third powerplant, forebay dam and appurtenant structures. (Negotiated Contract.)	Marcel Breuer and Associates, New York, N.Y.	250,000
DS-6606	Central Valley, Calif..	Mar. 26	Three hundred 10-, 12- and 14-inch vertical flowmeters for Westlands Water District distribution system.	Emerson Electric Co., Brooks Instrument Division, Hatfield, Pa.	768,350
DC-6611	Central Valley, Calif..	Mar. 13	Construction of 7-mile San Luis drain, Sta. 6855+00 to 7237+00.	Darkenwald Construction Co., Inc., Sacramento, Calif.	246,433
100C-969	Columbia Basin, Wash.	Feb. 15	Construction of 11.8 miles of buried pipe drains and 0.04 mile of open ditch drain, Blocks 42 and 43.	Equipco Contractors, Inc., Ephrata, Wash.	225,918
200C-687	Central Valley, Calif..	Jan. 24	Construction of interceptor drain along San Luis canal between Sta. 123+90 and 192+75.	Syblon-Reid Co., Los Banos, Calif.	124,157
200C-690	Central Valley, Calif..	Jan. 11	Gravel surfacing O&M road along Reaches 3 and 4 of San Luis canal.	Huntington Brothers, Napa, Calif.	123,660
300C-268	Colorado River Front Work and Levee System, Ariz.	Jan. 30	Construction of 3.8 miles and surfacing of 6.4 miles of haul roads for Arizona bankline and Topock Marsh dike and furnishing and placing riprap for bank protection.	Earth Movers, Inc., Oracle, Ariz.	165,980
300C-271	Colorado River Front Work and Levee System, Ariz.-Calif.	Mar. 8	Construction and surfacing of 4.2 miles of haul roads and bank protection structures, Sta. 280+00 and 449+00.	Lloyd R. Johnson, Rialto, Calif.	321,753
300C-272	Colorado River Front Work and Levee System, Ariz.	Mar. 22	Furnishing and placing riprap for bank protection, Sta. 1872+50 to 2026+70, and constructing haul roads and tieback levee.	Paul J. Hubbs, dba Paul Hubbs Construction Co., Rialto, Calif.	315,767

In its assigned function as the Nation's principal nature resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

U.S. GOVERNMENT PRINTING OFFICE: 1968 O—292-242

Major construction and materials for which bids will be requested through May 1968*

Project	Description of work or material
Central Valley, Calif.	Constructing 33 miles of 12- through 66-in.-diameter pipeline with heads varying from 25 through 100 ft, and 5 reinforced water screen and recirculating structures. Westlands Laterals 19, 21, 23, 25, and 26, near Mendota.
Chief Joseph, Wash.	Constructing the Whitestone Flats and North Branch Pumping Plants of reinforced concrete. The Whitestone Flats Plant will have a capacity of 15.44 cfs with three pumping units and about 950 ft of 27-in. buried discharge line. The North Branch Plant will have a capacity of 8.2 cfs with 2 pumping units and about 115 ft of 18-in. discharge line. At Spectacle Lake, about 7 miles northwest of Ellisford.
Colo. Rvr. Front Work & Levee System, Ariz.-Calif.	Constructing haul roads for access to and along the bank protection structures; clearing and shaping river bank; constructing training structure embankment; quarrying, loading, hauling, and placing rock riprap along bank protection structures. Palo Verde and Cibola Divisions, from 8 to 18 miles south of Blythe, California.
Columbia Basin, Wash.	Initial excavation for Grand Coulee Third Powerplant. Work will consist of common and rock excavation for future Forebay Dam and third powerplant, including cofferdam, service and access roads, parking area, and a concrete anchor block between the existing right powerplant and the future third powerplant (excavated materials are to be transported and placed along the river bank downstream of the dam in river bank stabilization embankments); constructing a concrete anchor block and placing concrete for the foundation of a cellular cofferdam; constructing a steel sheet piling cellular cofferdam, including timber crib retaining walls and a timber crib roadway over the top of the cofferdam; relocating a 12-in. waterline for the city of Coulee Dam; removing existing structures and improvements, including concrete structures, steel transmission line structures, electrical equipment and materials, and all or parts of existing commercial buildings and residential houses and improvements and services thereto; erecting about 3 miles of 115-kv transmission line; and miscellaneous work, including pumping and piping modifications and concrete repairs in left and right powerplants. (Prospective bidders may visit the site after Mar. 1, 1968. Arrangements to visit the site may be made by contacting: Third Powerplant Construction Engineer J. R. Granger, P.O. Box 155, Coulee Dam, Wash. 99116. Telephone: (509) 633-1360.)
Do	Constructing 9.2 miles of buried pipe drains, Block 20, west of Basin City.
Do	Constructing about 15 miles of buried pipe drains, Block 46, east of Othello.
Fryingpan-Arkansas, Colo.	Clearing, earthwork, culverts, and gravel surfacing for about 8.2 miles of relocated county road. At Turquoise Lake, about 5 miles west of Leadville.
Gila, Ariz.	Replacing cast-in-place concrete pipelines with 6.8 miles of 25-ft-head, reinforced concrete pressure pipe in sizes from 27- to 48-in. diameter. Extending from Yuma to about 8 miles east of Yuma.
Kendrick, Wyo.	Spillway repairs at Alcova Dam will consist of constructing a 12-in. thick reinforced concrete slab over the existing spillway chute floor; repairing areas of deteriorated concrete in walls, piers, and stilling basin floor; and unwatering and cleaning the stilling basin. About 30 miles southwest of Casper.
MRBP, Kans.	Glen Elder Reservoir clearing will consist of removing and disposing of all buildings and other improvements on 38 farmsteads; demolishing all foundations and concrete or masonry walls; filling in to natural ground surface all basements, storm cellars, cisterns, silos, and caves; capping all wells; removing all existing windmills and pumps; removing about 18.5 miles of fences; and constructing about 7.5 miles of 3-strand barbed-wire fence. Between Downs and Cawker City.
MRBP, Nebr.	Constructing VHF radio facilities will consist of grading and fencing; constructing concrete foundations; and furnishing and erecting radio towers and radio buildings at sites near Orchard, Spalding, and Wolbach. Work near Hartington will consist of grading and fencing the site and furnishing and erecting a radio building.
MRBP, N. Dak.	Furnishing and erecting 5 radio towers, constructing 5 radio huts, and associated earthwork, concrete, and electrical work. Near LaMoure, Bantry, Oakes, McClusky, and Harvey.
Do	Constructing Killdeer Substation will consist of constructing a 20- by 20-ft concrete masonry service building; concrete foundations; furnishing and erecting steel structures; and grading and fencing the area.
Do	Constructing Snake Creek Pumping Plant No. 1, a 2,055-cfs, 3-unit plant consisting of a reinforced concrete substructure; a superstructure of structural-steel frame with brick walls; a 170-ft, 2-span access bridge; 2,000 ft of access road; a substation; three 11-ft-diameter, 250-ft-long, steel-lined monolithic concrete discharge pipes; three 90-ft-long transitions; and a reinforced concrete discharge structure. Work will also include installing a 50-ton bridge crane; three hydraulically operated fixed-wheel gates and hoists; three pumping units with electric motors and vertical-shaft mixed-flow pumps. Between Garrison and Coleharbor.
MRBP, Wyo.	Constructing Glendale Substation will consist of constructing a 20- by 20-ft concrete masonry building; concrete foundations; furnishing and erecting steel structures; furnishing and installing one 5,000-kva, 69-4.16/2.4-kv, 3-phase power transformer, one 500-kva voltage regulator, one 4.16-kv circuit breaker, and associated electrical equipment; and grading and fencing the area. Furnishing and installing about 2 miles of single-circuit, 69-kv, wood-pole Cody Tapline. At Cody.
Parker-Davis, Ariz.	Constructing a 500,000-gpd water filtration plant. Parker Powerplant and Community, about 14 miles northeast of Parker.
Pacific Northwest-Pacific Southwest Intertie, Ariz.	Drilling, casing, and developing an 8-in. well, 800 ft in depth to provide domestic water for Liberty Substation. Near Phoenix.
Southern Nevada Water, Nev.	Excavation and constructing intake facilities for Pumping Plant No. 1 will consist of 12,000 cu yd of common excavation and 27,000 cu yd of rock excavation above site elevation, 230 ft of vertical 9- by 20-ft access shaft, 1,500 ft of intake tunnel which may be 13.5-ft-diameter unlined or 11.5-ft-diameter lined, 160 ft of 10- by 22-ft tunnel under bored raises, 20 bored raises of 205-ft length by 48-in. diameter each, 7,500 cu yd of rock excavation for structures and a surge chamber at yard elevation; placement of 500 cu yd of miscellaneous concrete work; and construction of 3,800 ft of access road to the site. 6 miles north of Boulder City.
Do	Constructing 2.4 miles of 96-in.-diameter reinforced concrete pipe with heads varying from 25 to 550 ft; one 5-million-gallon reinforced concrete earth-covered forebay tank, 198 by 230 ft; 1 reinforced concrete forebay tank, 176 ft in diameter and 19 ft deep, with reinforced concrete roof; 1 reinforced concrete regulating reservoir, 176 ft in diameter and 16 ft deep, with reinforced concrete roof; 1 reinforced concrete surge tank, 28 ft in diameter and 57 ft high, with reinforced concrete roof. About 6 miles north of Boulder City.
Weber Basin, Utah	Constructing a concrete-lined lateral system and a buried pipe drainage system. About 7 miles northwest of Ogden.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

MAN in danger

MAN . . . AN ENDANGERED SPECIES? The latest conservation yearbook from the Department of the Interior takes a look at the ages-old battle between man and his environment. It considers the signs which indicate that both sides may be losing. In this book, the series embarks on a new theme—is man polluting, overcrowding, plundering and reshaping his own habitat into an environmental trap? This Yearbook, like its forerunners, is addressed to concerned citizens who seek to turn the environmental tide in favor of both man and Nature.

1. MAN . . . AN ENDANGERED SPECIES? Conservation Yearbook #4

100 pages, fully illustrated with 75 photos—55 in natural color. Catalog No. I 1.95:4 **$1.50** a copy.

America's rich natural resource heritage is the subject of this continuing story of conservation.

2. THE THIRD WAVE Conservation Yearbook No. 3

The title is based on the historic third phase of conservation—the ecologic approach—or how all aspects of our environment interrelate and affect us. 128 pages, 175 photos, 118 in full color. Catalog No. I 1.95:3 **$2.00** a copy.

3. THE POPULATION CHALLENGE Conservation Yearbook No. 2

This outstanding publication examines the crucial decisions that must be made if we are to meet the challenge of our rapidly growing population and maintain a livable environment in years to come. 80 pages, 85 photos, 38 in full color. Catalog No. I 1.95:966 **$1.25** a copy.

4. QUEST FOR QUALITY Conservation Yearbook No. 1
The widely acclaimed pioneer publication in the Interior Department's Conservation Yearbook series presents the resource dilemmas facing a nation determined to preserve and improve a quality environment. 96 pages, 209 photos, 72 in full color. Catalog No. I 1.2:Q3 **$1.00** a copy.

Mail Order Form To:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

For Use of Supt. Docs.

Enclosed find $ ____(check, money order, or Supt. of Documents coupons).

Please send me:

1.—Man . . . an endangered species—$1.50 per copy.
2.—The Third Wave—$2.00 per copy.
3.—The Population Challenge—$1.25 per copy.
4.—Quest for Quality—$1.00 per copy.

Name ....

For prompt accurate shipment please fill in the mailing label below

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

POSTAGE AND FEES PAID
U.S. GOVT. PRINTING OFFICE

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

Name ....

Street Address ....

August 19

RECLAMATION era

A WATER REVIEW QUARTERLY

August 1968 • Vol. 54, No. 3

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER. Three underwater inspection men inspecting San Luis Canal where it is 257 feet wide, 36 feet deep.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 30 cents (single copy). Subscription price: $1.00 per year (25 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Tangible Headway

Consider what has been accomplished by just one Federal agency, the Bureau of Reclamation, during the past 9 years.

Capital investment in dams, canals, powerplants, irrigation systems, and other features totaled $2.9 billion, nearly a third larger than any preceding 9-year period.

Irrigation lands under ditch increased 1.5 million acres, a sizable area renewed by life-giving water from reservoirs, of which there are 50 new ones.

Water for homes, gardens, parks, and industry doubled; as did recreation at the attractive man-made lakes.

Work started on the first large-scale projects utilizing Missouri River water, and on the world's largest powerplant at Grand Coulee Dam.

Bureau scientists, collaborating with the rest of the scientific community, launched a program to milk the rivers of the sky.

All along the line problems loomed up, as they always will in multiple-purpose water developments. But they were overcome and betterments made real by persistence and cooperation.

Moreover, this is a reimbursable program—nearly 90 percent of the construction costs are returned to the Treasury.

It all requires people who are interested in and willing to work cooperatively to develop our God-given natural resources. It also requires plenty of that old, never-say-die western spirit. And it spells, I am pleased to report, tangible headway in the herculean challenge, and keeping an eye to the future of meeting the water requirements for the arid and semiarid West.

Floyd E. Dominy

FLOYD E. DOMINY
Commissioner of Reclamation

Central Valley Project and its new features top records as facilities for water control

Goliath CVP Grows, San Luis Dedicated

The 103-mile long San Luis Canal carries water for irrigation and municipal use, which previously flowed unused to the ocean.

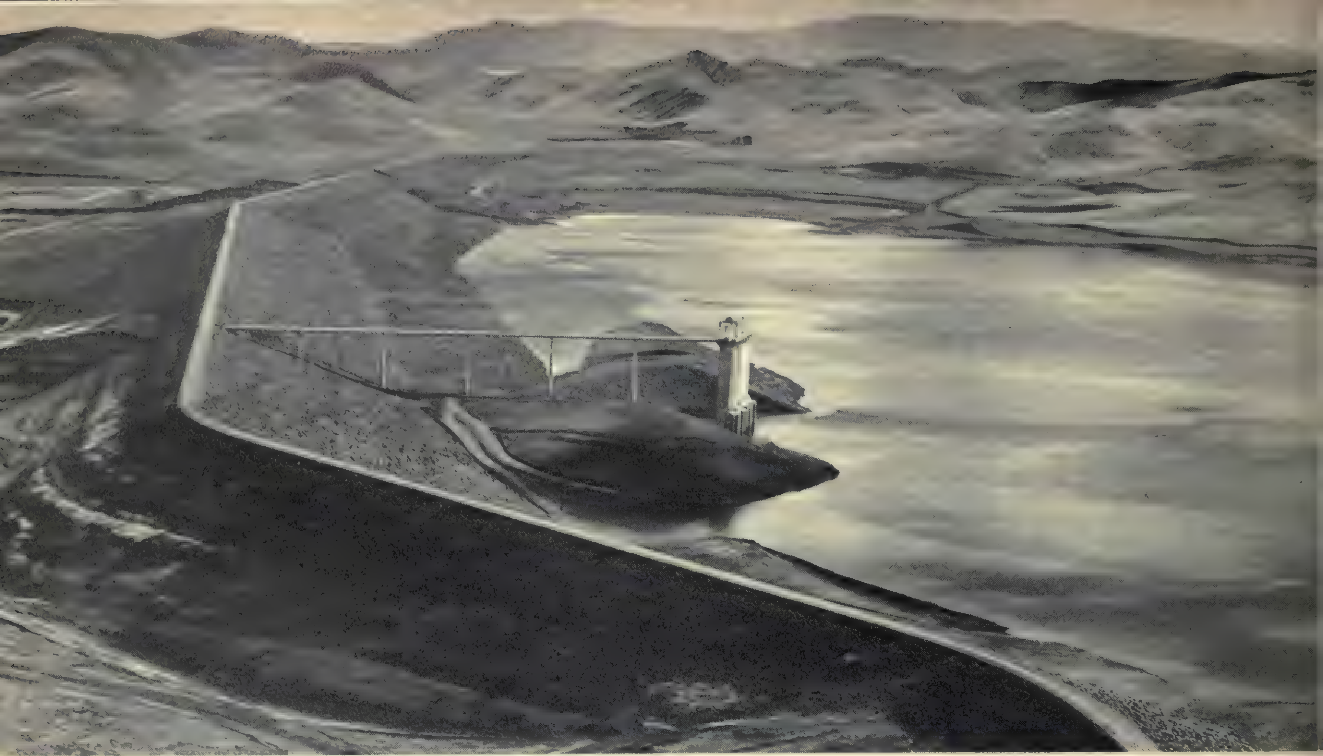
FROM wherever it is viewed, or with whatever device it is measured, Central Valley Project comes out big—one of the largest such water developments in the world.

The land area it covers, the cost to build the huge features, the size of its dams, canals and powerplants are a few of the items where measurements are startling.

But other Goliath-sized items are its contributions: The amount of irrigation, municipal and industrial water which it delivers, the electrical energy it produces, the income from sale of water and power, or even its affect on the national economy.

The Central Valley Project is located in 28 of the 58 counties in California, and project facilities have been built in 22 counties. With a length of over 400 miles and an average width of 120 miles, the project limits exceed the combined areas of eight Eastern States—Rhode Island, Delaware, Connecticut, New Jersey, Massachusetts, New Hampshire, Vermont, and Maryland.

A great many umbrellas would be seen outdoors if the stored waters of the Central Valley Project could be changed into rainfall. We would have a refreshing one-inch soaker over all of England,



This shows the 3½-mile San Luis Dam with the water level as it was last March.

Scotland, Wales, Ireland, Belgium, Holland, and Denmark. This unusual wetting could also include a good shower over Delaware, Rhode Island, Massachusetts, New Jersey, and Connecticut.

However, in the Central Valley Project, this vast amount of water is moved through big canals. The excavation for the San Luis Canal, which was recently completed, is the equivalent of a trench 16½ feet wide and 10 feet deep, stretching from Denver to Boston. At the head of this canal, which actually is 103 miles long, the water is almost as deep as the Suez Canal and wide enough to pass any vessel that can go through the Panama Canal.

152-Mile Canal

Even longer than the San Luis Canal is the Friant-Kern Canal—152 miles, and the Delta Mendota Canal at 117 miles. Extending from northern California to the southern end of the great CVP, this is the longest major water transport ever accomplished by man.

To get this water into canals and move it by gravity flow, it frequently has to be pumped uphill. The Tracy and Dos Amigos Plants pump it up 197 feet and 125 feet respectively—comparable to the 167 feet that water at Niagara Falls tumbles down.

The largest distribution system which the Bureau of Reclamation has ever built is now under construction. This is the Westlands system with 1,000 miles of pipelines to carry water to about two-thirds million acres.

Three large storage dams play a key role in this water supply project: Shasta is still one of the world's largest. When Trinity Dam was completed it was the world's highest earthfill dam. Now San Luis Dam, completed a year ago, is the largest earthfill dam ever constructed by Reclamation. A walk across the latter amounts to a 3½-mile hike and it contains about as much fill as 50 of the great pyramids of Egypt.

The harnessing of plunging water for power also is impressive. An example is Shasta Dam, where the water rushes into the powerplant through penstocks 15 feet in diameter—pipes so large a bus could be driven through them. In this and other Central Valley Project powerplants, the 5.7 billion kilowatt hours of electricity produced last year would easily have met all the power needs of a million homes.

Seven Powerplants

Power from the seven plants speeds along 1,200 circuit miles of transmission lines. Last year the power sales were more than $22 million and the water sales about $7 million.

More than 1¼ million acres of land received a

supplemental supply of water for irrigation last year and over 40,000 acres received a full supply. For municipal and industrial use, over 35 billion gallons were delivered. To cite only one example of people using a reservoir for recreation, almost 3.4 million visitor days were counted at Folsom Lake in 1967.

The project will have a favorable effect on the national economy. That it will pay for itself in sale of power and water is assured, but that by no means tells the complete economic story. Crops raised on project lands last year had a value of about $600 million. Three years ago the project prevented $85 million in flood damage. Such benefits as the expanding industry made possible by low-cost power, or the power and water delivered to national defense installations, or salinity control in the delta area, will occur year after year. Taken altogether, the Central Valley Project, like the Golden State itself, IS tremendous!—WMD

Sec. Udall Dedicates

Secretary of the Interior Stewart L. Udall dedicated the $312 million joint-use San Luis Unit of the Central Valley Project last April 20. Water control structures in this unit include giant dams, canals, generators, and pumping plants which link together the two joint-use projects of the Bureau of Reclamation and the State of California.

"We have erected a structure," Secretary Udall told the crowd of 3,000 gathered for the ceremonies, "which can proudly bear a sign: Man was Here!"

If such a sign were erected, it would be dwarfed by the sheer bulk of San Luis Dam. This structure is the sixth largest ever built, and has a crest 3½ miles long. San Luis Canal is 103 miles long, 257 feet wide and 36 feet deep, one of the few manmade structures expected to be identifiable by astronauts who reach the moon.

Superlatives must be used to describe other San Luis facilities as well:

San Luis Reservoir is an offstream reservoir so big it can hold enough water to meet every need in the city of New York for an entire year.

10,000 Gallons a Second

San Luis Pumping-Generating Plant contains eight generators with a total capacity of 424,000 kilowatts, greater than the nameplate capacity of the mighty Shasta Powerplant located more than 200 miles north. When reversed, these pump-generator units become huge electric motors each of which can lift 10,000 gallons of water 320 feet in 1 second.

O'Neill Dam is 2½ miles long, 86 feet high, and 420 feet thick.

The six pumping units in the Dos Amigos Pumping Plant lift nearly 100,000 gallons of water each second.

The name Dos Amigos, meaning "two friends," is symbolic of the close cooperation between the State of California and the Federal Government and their unique partnership in the construction and operation of San Luis.

"Nowhere else has the Federal Government cooperated so closely with the government of a State on so large a development," said Secretary Udall.

In 1930's

The Central Valley Project was first authorized as a State project in the 1930's, but when financing was made impossible by the Great Depression, the State called upon the Federal Government for help. In 1937, the Central Valley Project was authorized for construction, operation, and maintenance by the Secretary of the Interior.

The job of building the dams, canals, powerplants, and pumping plants which now make water and power available for use throughout California's great Central Valley thus was given to the Bureau of Reclamation. The investment in the CVP facilities in operation, under construction and authorized to date is more than $2 billion.

The State Water Project, authorized by the California State Legislature in 1960, bears a similar price tag. Construction is expected to be completed on the major features of the State Water Project by 1972. Basically, the plan of the State Water Project, like the Central Valley Project, will take surplus water from northern California streams, which once ran largely unused to the ocean, and put it to beneficial use in the southern part of the State. Much of this water will be for the rapidly growing metropolitan areas from Los Angeles to San Diego.

Contract Efficiencies

Because the Bureau of Reclamation was able to adhere closely to its construction schedule—and because of tight competitive bidding—construction costs of the joint-use facilities were held to $312.5 million, instead of $433 million previously estimated. Since the joint-use cost agreement was 55

Delicious casaba melons being harvested on Reclamation's CVP project near Los Banos, Calif., typify the high value crops in the area.

percent for the State and 45 percent Federal, the savings amounted to $66.3 million for the State and $54.2 million for the Federal Government.

In addition, many more millions of dollars will be saved by both the State and Federal Government through single unit operation and maintenance of the San Luis Unit facilities.

Bureau of Reclamation water flowing through the San Luis Canal will serve 614,000 acres of agricultural land, most of it in the Westlands Water District. Because of the fertile soil, it is expected that the value of the crops grown on the land, will increase by more than $210 million a year.

For every dollar spent in construction, operation, and maintenance of the San Luis Unit, Bureau economists expect return benefits of more than $6.

Other Works

Although the San Luis joint-use facilities are virtually complete, the Bureau still has some $208 million worth of Federal-only facilities to finish as part of the unit. This includes the $193 million Westlands distribution and drainage system, the Pleasant Valley Canal and Pumping Plant and the San Luis Drain.

Secretary Udall indicated in his dedicatory remarks that while the cooperation between the State of California and the Bureau of Reclamation in building San Luis is unique as of today, it may have set a pattern for future major water resource development in California.

"I anticipate there will be other such joint ventures," the Secretary said: "This San Luis Unit we are dedicating is good evidence of what can be done when we share an idea and put our talents and energies constructively to work to make it a reality."

IMPACT IN OTHER STATES FROM SAN LUIS CONSTRUCTION

"Certificates Of Shares In San Luis," which recognize the dollar benefits of several States as a result of construction efforts, were presented at the dedication by Reclamation Commissioner Floyd E. Dominy.

The dollar figures were based on the materials and equipment purchased for the construction of the San Luis Unit by the Bureau of Reclamation and its contractors.

Million-dollar plus "shareholders" are California having $26.4 million in purchases; Illinois with $12.9 million; New York, $9.3 million; Ohio, $6.9 million; Texas, $3.5 million; Wisconsin, $3.3 million; Washington, $2.7 million; Pennsylvania, $2.1 million; Massachusetts, $1.3 million; and Michigan, $1.1 million.

The 11 other States where significant purchases were made include: Oregon, Idaho, Utah, Colorado, Indiana, Kansas, Oklahoma, New Jersey, Maryland, Alabama, and Missouri.

Commissioner Dominy said that continuing nationwide benefits would result from the project's increased production in various forms: More abundant food and fiber because of more irrigation, various water-oriented recreation activities at unit areas, and development of related industries.

# # #

Shaggy, hardy cattle and flavorful meat

Big Blacks from Galloway

by CAROL PROHASKA, Ephrata, Wash.

Standing taller than this hardy Galloway cow and her furry new calf are young farm hands, from left, Mike and Lisa Holm and Kay York.

A HARDY breed of cattle from Scotland, which had fallen into near oblivion, have made an appearance on a ranch in Washington.

These old pioneers are Galloway cattle, and David Holm, who came to the area last September, is raising them for breeding stock on his irrigated farm on the Columbia Basin Project.

The Galloway herd, which was started about 4 years ago on Mr. Holm's ranch at Naselle, Wash., now has two herd bulls, 50 cows, 12 yearling bulls and six new calves. The bulls are Forest Range Zenith Drawl and his offspring Blue Peter of Pacific, both originally from the Forest Range in California owned by George Daniels, one of the foremost breeders of Galloway cattle in this country.

Mr. Holm is already achieving some measure of success as a breeder and one of his entries at the Montana Galloway Association show at Billings in March was selected Reserve Champion Female.

Galloway cattle are natives of Scotland. They were mentioned in writing as early as 1530, when they were referred to as the "big blacks from Galloway, after the province where they were first raised. Since then, the name has been shortened to mere "Galloway."

First Shaggy Breed

The first of the shaggy breed to cross the Atlantic was a herd brought to Ontario, Canada, in 1853. Some of their descendants made their way to the United States in 1866 when Michigan State College purchased a small herd for experimental work.

Partly because of the college's work, the breed gained followers in the Midwest from the turn of the century until the early thirties. However, a series of misfortunes, including a train fire which wiped out the show herd of one of the leading breeders, started them on the decline, and between 1935 and 1950, they were little heard of in the United States.

There were a few cattlemen, particularly in the West, however, who continued to breed the animals because of their great hardiness and suitability to range life. Some of this hardiness derives from an extremely heavy coat of hair which appears in the fall and makes them resistant to extremes in winter weather, and from their strong feet and legs permitting easy foraging where other cattle have problems.

Galloways have been bred over the years for this vigor, and for their fine carcasses which are noted for having less external fat than other breeds and a high percentage of beautifully marbled, flavorful, lean red meat. According to Mr. Holm, these are the qualities which have made them popular for cross breeding.

Heavy Calves

Holm says they produce calves that add more pounds with less cost and care. For instance, although the Galloway is not known as a particularly good milker, they produce exceptionally heavy weaning calves. It is not uncommon for calves from a mature cow to wean out at more than 600 pounds. At 1 year of age, steers often reach the thousand-pound mark.

Now that Galloways are back in the picture, Mr. Holm feels sure they have a bright future. If it is anything like the increase in overall livestock production, which has taken place on the Columbia Basin Project in the last 10 years, this is a safe prediction. # # #

TV Show Stars FISH

THE stars on two television screens located at the Bureau of Reclamation's Red Bluff Diversion Dam across the Sacramento River, Calif., are all fish—salmon, steelhead and rainbow trout, shad, striped bass, squawfish, suckers, and other rough fish, plus the eel-like lamprey.

The Bureau of Sport Fisheries and Wildlife catches their image on the two TV cameras of a closed-circuit system as they pass through a lighted, specially designed viewing chamber at the head of each fish ladder.

Most of these fish are on the way upstream to spawn, but some go back and forth several times through the viewing chamber before completing their final trip.

In the approximately one-fifth of a second an image appears on either screen, a trained observer identifies the species, tallies it on pushbutton counters, and enters the information hour by hour in a log book. The screens are watched 16 hours a day 7 days a week.

A few night counts are planned as the movements of the fish during the hours of darkness are unknown.

The facility is reported as the only one in the world where fish are counted by television. The Bureau contemplates adding a video tape system, hopefully in color, which can be run unattended and viewed the next day. The tape could also be shown to the public in a visitation center planned for the recreation area to be developed at the dam.

Possible Video Taping

An additional feature now in the experimental stage would be the automatic activation of a video tape system as the fish pass the camera. It would turn itself off when the fish passed out of viewing range. The feasibility of such a system has been demonstrated in the laboratory, but a practical field application remains to be worked out. Video tape counting could cut the personnel requirements by more than half.

The televised fish counting at Red Bluff has been so successful that similar TV installations are being considered at several locations on the Columbia and Willamette Rivers.

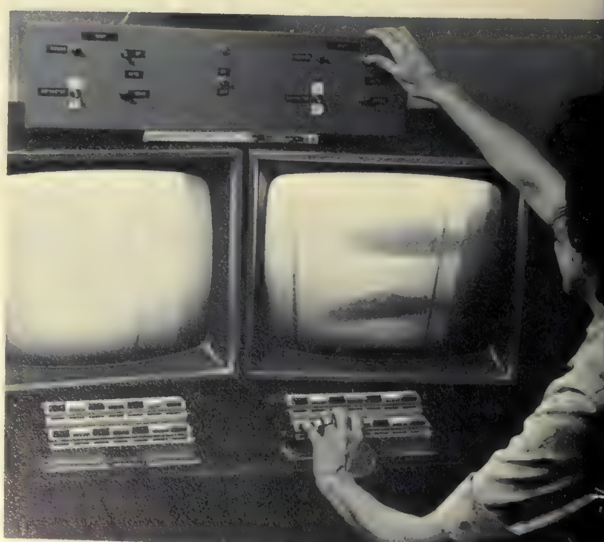
Prior to fish counting by closed circuit television at Red Bluff, fish counters entered one of the small, cold underground counting rooms by climbing down an open hatchway 20 feet to the concrete floor. A 3-foot by 5-foot observation window gave them a view of the 1½-foot-wide channel the fish use to bypass the dam.

Feature attraction on these television screens is the upstream migration of the parade of important commercial and sport fish whose sole interest is reproduction. The viewer's job is to record their passage through the dam.

Between July 1, 1967, and January of this year, 104,000 fish were counted, including 56,000 king salmon, 14,500 steelhead, 1,200 rainbow, 129 shad, 600 squawfish, 4,000 suckers, and 1,000 lampreys. Other fish counted included 15,800 grilse or downstream migrants of various species, 10,000 rough fish and one striped bass.

The fish facilities were designed and built by the Bureau of Reclamation, using criteria developed by the Bureau of Sport Fisheries and Wildlife, and the Bureau of Commercial Fisheries and the California Department of Fish and Game. # # #

Television cameras for the fish counting operation are located at the top of the fish ladders on each end of Red Bluff Diversion Dam on the Sacramento River.



Daring Scientist J. WESLEY POWELL *Spurs Water Saga*

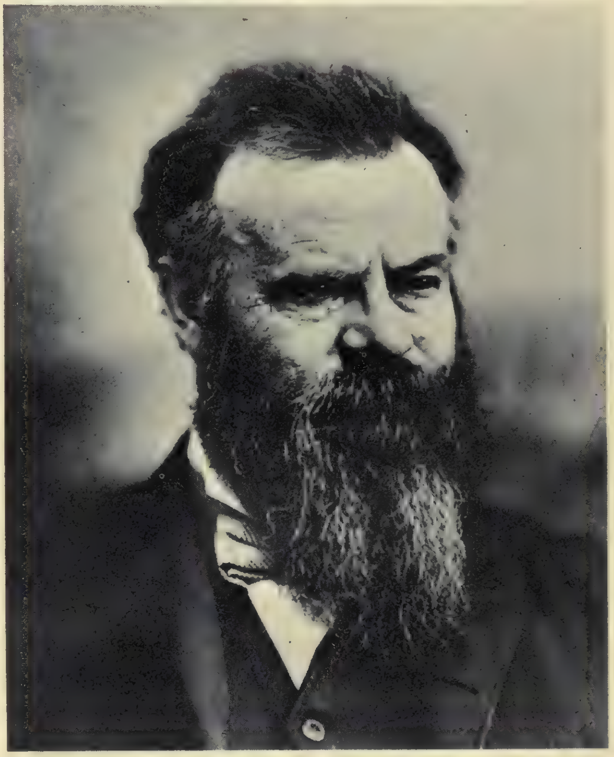
EDITOR'S NOTE: Last June 11 was a significant legislative milestone in the development of the American West that went virtually ignored by the academic community and the press. It was the centennial of Federal assistance in evaluating the water resources and reclamation potential of river regions, ultimately to be a major factor in the amazing growth of the modern West.

On June 11, 1868, the first President Johnson signed a Congressional Act authorizing the Secretary of War to furnish supplies to the John Wesley Powell expedition to explore the unknown Colorado River in 1868 and 1869. (The first irrigation development to receive funds for construction from the U.S. Government was on the Colorado River Indian reservation, Ariz., in 1867.)

The modest Federal provisioning for Powell made scarcely a dent in the national budget of that time, but it resulted in valuable reports and mapping of the Colorado River and some of its tributaries. It also helped make a nationally known figure out of the self-taught, one-armed soldier-scientist, Major John Wesley Powell, whose centennial as an intrepid explorer will be observed next year. And it was the forerunner of continuing Federal participation in, and assistance to, water resource development for irrigation and other purposes in the arid and semi-arid states of the West.

Some of these still little-known activities and contributions will be reviewed in a special issue of *Reclamation Era* in 1969 as a feature of the Powell Centennial year.

Glimpses of the energy and inquiring mind of Powell, the scientist, are visible in the brief excerpt on these pages from one of the excellent biographies on this great man, *Powell of the Colorado*, by W. C. Darrah. This excerpt recounts Powell's preparations for his first Colorado River expedition, including references to his interest in hydrological and irrigation studies and to the 1868 Congressional Act that helped make his explorations possible.



Major John Wesley Powell

And lest this emphasis on a chapter in Powell's exploring achievements gives an unbalanced picture of one of the greatest scientific minds of 19th century America, we also are reproducing appraisals of Powell by the late Bernard DeVoto and Melville Bell Grosvenor, which should help keep the man and his profund achievements in perspective.

"a great man . . . now we are beginning to understand him"

"His career was an indomitable effort to substitute knowledge for the misconceptions and to get it acted upon. He tried to repair the damage they (the misconceptions) had done to the people and the land and to prevent them from doing further damage. He tried to shape legal and political and social institutions so that they would accord with the necessities of the West. He tried to conserve the West's natural wealth so that it could play to the full its potential part in the future of the United States. He tried to dissipate illusions about the West, to sweep mirage away. He was a great man and a prophet. Long ago he accomplished great things and now we are beginning to understand him . . . even out West."

BERNARD DeVOTO

(Excerpt from the late Mr. DeVoto's introduction to the book entitled: *Beyond the Hundredth Meridian*, by Wallace Stegner, published by Houghton Mifflin Co., Boston, Mass. Reprinted with permission.)

"was in a quest for knowledge—not thrills . . . vision of . . . the need to irrigate"

"Most important of all, Major Powell was in a quest for knowledge—not thrills. A man of ideas, as well as a man of action, he crossed the dry, trackless prairies many times, seeking to learn how man could wrest a living from the 'Great American Desert'. Major Powell was the first to recognize its potential. He also stood alone in his clear vision of the problems that Americans would face—the need to irrigate, for instance—in their inevitable mass migrations into the strange new lands of the frontier.

"Not the least of Major Powell's talents was that of organization. He not only took a key role in the formation of two great government bureaus; he was instrumental in the founding of the National Geographic Society, the Cosmos Club, which he served as first president, and the Geological Society of America."

DR. MELVILLE BELL GROSVENOR
Editor-in-Chief and Chairman of the
Board of the National Geographic Society

1868—ACROSS THE CONTINENTAL DIVIDE

Powell spent the winter of 1867–1868 making preparations for a more ambitious expedition to culminate in a passage of the Grand River to its junction with the Colorado. (Mr Powell had been West and returned. This discussion is on his preparations to actually explore the Colorado River area for the first of two times.)

Barely 2 weeks after returning to Normal (Illinois State University) he appeared before the annual meeting of the board of education and with characteristic enthusiasm stated that his explorations and collecting had been successful beyond expectations. The total expenses amounted to more than $2,100, more than half of which Powell paid himself.

The board, considering its financial support judiciously expended and efficiently used, promptly appropriated $600 to finance a second trip, and promised further aid in the prosecution of the Professor's Rocky Mountain explorations.

The many boxes and parcels of specimens which had been shipped back to the museum were opened and rough sorted, but only a general inventory could be made in the limited time available.

"We confess our surprise at the amount of material there collected. . . . The Professor and four assistants were busy unpacking and preparing the various specimens. . . . Too much credit cannot be given to Professor Powell. He works 16 hours a day and pays his assistants out of his own meager salary." *Daily Pantagraph*, Jan. 25, 1868.

As many duplicates as possible had been collected so that they could be distributed among the various cooperating institutions.

By agreement, any unique specimen of a given kind was retained for the Normal Museum. The field catalogue showed that they had found nine hundred birds, several hundred plants, and thousands of insects. There were smaller series of rocks, minerals, and fossils, and reptiles and skeletons of mammals. It had been a successful summer.

Enthusiastic Lecturing

Powell discharged his obligation to lecture in geology with scintillating enthusiasm. He had large classes of eager students who wanted to hear of his adventures and firsthand observations. His descriptions of Pike's Peak, Mount Lincoln, and

the mountain parks were eloquent and vivid. There were few photographs or stereopticon slides in those days, and a lecturer had to rely on words and crayon sketches to capture the imagination of his listeners.

Although Powell enjoyed his lecturing and teaching, apparently he was not satisfied. Perhaps he mused on the profession of teaching students, many of whom would return to their farms or in a few years enter business and give up the intellectual pursuits for which they had come to college—a thought which must arise eternally in the minds of teachers. Never bored, Powell was nevertheless searching passionately for something else to engage his energy.

In March, Major Powell spoke before the annual meeting of the board of the Illinois Industrial University on his Rocky Mountain expedition. The immediate purpose was to appeal for additional aid, but it so happened—probably after preliminary negotiations of which there are no records—that John Wesley Powell "was unanimously elected to the Professorship of Natural History, his term of service to commence at such time as may be agreed upon between himself and the committee on Faculty and Courses of Study." (Ill. Ind. Univ., 1st Ann. Rep. Trust., 1867–1868, p. 127.)

This offer and his tentative acceptance was not announced because the Major was in no position to leave Normal, not only for his prior commitment there, but also because of his advanced plans to return to the mountain country.

Reported to be an Indian acquaintance of Powell.

Consulted With General Grant

In April, Powell went to Washington and consulted General Grant concerning the possibility of drawing rations again from western outposts, this time for a party of 25 men. The General suggested that he put his request in writing and state the purpose of the proposed expedition. The letter, dated April 2, 1868, was a routine request except that in it Powell mentioned two significant ideas:

It is believed that the Grand Canyon of the Colorado will give the best geological section on the continent. . . .

And the other:

Nor is it necessary to plead the value to the War Department of a survey of that wonderful region, inhabited as it is by powerful tribes of Indians that will doubtless become hostile as the prospector and the pioneer encroach upon their hunting grounds.

Grant gave his approval and sent Powell's letter with one of his own to Gen. A. B. Eaton, who was commissary general of subsistence. To their mutual surprise, General Eaton declined to give his consent, assuming that it would be illegal to issue such rations since Powell was neither a civilian employee of the government nor a member of the military service of the United States.

Persevering With Officials

Eaton in turn suggested that Professor Powell obtain the enactment of a law which would accord him the aid that he desired. It was far more difficult to gain congressional approval for a private venture than to obtain the consent of a general or even the Secretary of War to certain privileges at army outposts. Nevertheless, Powell called on Rep-

308-859 O - 68 - 2

resentative Shelby M. Cullom and Senator Lyman Trumbull, both of Illinois, to gain their support.

On April 15th Mr. Cullom introduced in the House a joint resolution which would authorize the Secretary of War to furnish supplies to the Powell expedition. There was little opposition in the House though considerable antagonism was encountered in the Senate. Accordingly, Joseph Henry, secretary of the Smithsonian Institution, wrote a letter of introduction for Powell to James A. Garfield, then Representative from Ohio and a most influential Member of the House.

Secretary Henry explained that no personal or pecuniary interests were involved and that the venture was to be a survey of little-known country in one of the most interesting regions of our continent. He noted that Professor Powell intended to give special attention to the hydrology of the mountain system in relation to agriculture and that the water might be reclaimed for use in agriculture by a judicious system of irrigation founded on a critical knowledge of such hydrology.

Support Came

Although the Smithsonian Institution had no funds to give support to Powell's party, Secretary Henry did provide various scientific instruments. Mr. Garfield was a useful ally and, although a Member of the House, was able to gain the cooperation of various Members of the Senate.

Finally on May 25th, while Powell was anxiously awaiting some answer to his request and was forced to delay final preparations for the expedition, the Senate took up the joint resolution and began the debate. After the usual questions concerning Powell's identity and the objectives of the expedition, the main criticisms of the bill crystallized. The objection was that such a precedent might invite other individuals to seek financial support from the Federal government for projects which were equally deserving and equally costly.

Admittedly, as Mr. Trumbull stated, the area that the professor intended to explore—six or seven hundred miles along the Colorado River—was marked upon the Federal maps as unknown and perhaps never before seen by a civilized man.

Powell's Modest Request

He called to the attention of his colleagues that Powell did not ask for a military guard, such as many other parties had required, because "his knowledge of the Indians and his acquaintance with the country is such that he is willing to take care of himself."

Finally the opposition was reduced to the single objection that the bill was not limited—that the professor by asking a carte blanche might obtain support for a hundred men—whereupon an amendment was offered limiting the supplies to 25 persons. Then, without further restrictive amendments, a vote was taken and the measure passed, 25 to 7, with 20 Senators absent.

Inasmuch as the presidential signature was assured, Powell returned to Normal even though final passage did not take place until President Johnson signed the bill on June 11th.

Powell organized a larger party, again representing different branches of natural science, especially geology, botany, ornithology, and entomology. The Smithsonian Institution had furnished a sextant, barometers and chronometers, and a few other facilities. All personal expenses were to be borne by individual members of the party.

To Illustrate Resources

The main purpose of the expedition was to gather a large collection of specimens representing the different sciences and illustrating the resources of the country. Also, before leaving Illinois it was understood that whatever else might or might not be accomplished, ascent of Long's Peak would be attempted. Repeated efforts to climb this 14,000-foot peak had failed. In fact, some argued that Long's Peak would never be ascended.

The party for the 1868 expedition (boat party actually left Wyoming in 1869) included 21 persons. Two or three were professional biologists; the remainder were amateurs and upperclassmen at Normal and Wesleyan.

Rev. George Smith accompanied the party as an ethnologist and Dr. George Vasey as a botanist. Dr. Henry Wing, a physician going west for his health, and Mr. J B. Taylor were interested amateurs.

Rev. J. W. Healy and Rev. W. H. Daniels, both from Chicago, joined as historians and correspondents to keep the newspapers informed of the progress of the expedition. Mrs. Powel was the only woman member, as in the first trip (not a Colorado River trip). Walter Powell, the Professor's younger brother, was taken along as a zoologist.

The other members were E. D. Poston, John Aiken, Henry Wood, Rhodes C. Allen, W. H.

This is part of the Green River, an October 1956 view, through which Major Powell boated. After this photo the multipurpose Flaming Gorge Dam was built on the site.

Bishop, S. M. Garman, L. W. Keplinger, Lyle Durley, Ned E. Farrell, William Woodward, John Wheeler, and—Chamberlain.

Just Before Leaving

Just before taking leave of the college to begin the trip, Powell appeared before the board on the evening of its spring meeting on June 24th to give an account of his past work and a description of the proposed route of his second expedition. Following a short address he took the members of the board to the museum and explained briefly the many additions to the collections which had been made during the preceding season. Much of the material had not yet been prepared nor classified, but the size of the museum's collections had already been doubled.

The board of education of the State of Illinois appropriated an additional four hundred dollars to purchase instruments which could well be used in the expedition to the Colorado River. This appropriation came too late to benefit the 1868 party, but it did enable Powell to place orders for valuable instruments which could be used in subsequent expeditions.

Before daybreak on Monday, June 29th, the party . . . left Normal for Chicago, arriving there at five o'clock in the morning. Almost the entire day was idled away waiting for a special car on the Chicago and Northwestern Railroad which was to take them to Omaha, Nebr.

After a tedious delay, during which a large banner lettered "Colorado Scientific Exploring Expedition" was nailed to the side of the railroad car, they boarded the train, which pulled out at three o'clock in the afternoon.

WILLIAM CULP DARRAH

(*Powell of the Colorado*, by William Culp Darrah (Princeton University Press, 1951): excerpts from chapter 6.)

PECAN SUCCESS IN NEW MEXICO

Photographed by H. L. Personius, Amarillo, Texas

A variety of equipment is used to hasten the pecan harvest at Stahmann farms near Mesilla, N. Mex.

[1] These farms are irrigated by water from the Bureau of Reclamation's Rio Grande Project. While a farm operator turned water into the lettuce rows last March, nearby pecan trees also got irrigated.

A number of other agricultural products are efficiently produced there by well coordinated irrigation and management methods, some of which are described in former issues of the *Reclamation Era*.

[2] The arm of the treeshaker reaches several feet into the branches, grips one branch at a time, vibrates it, and makes pecans come pelting down.

[3] In areas where the trees are young, cotton is grown in the spaces between rows of trees. To efficiently net the pecans from among such plantings, large deflecting screens mounted at a slant on the side of two tractors, follow beside the tree shaker and bounce the falling pecans away from the rows of cotton. The screens eliminate the step of recovering the pecans by hand from the cotton, which would add considerable time and expense to the harvest operation.

[4] After the trees are cleared and the pecans are on the ground, a sweeper comes along, picks up the pecans as well as leaves and twigs, and puts them to one side in windrows in readiness for the harvester.

[5] Then the harvester enters the grove. This apparatus separates the pecans from the leaves and twigs by forced gravity. Because of their weight the pecans enter a chute and fall into the wire mesh trailer towed behind.

When trailers are full they are unhooked from the tractor, wait for a return trip, then are pulled, one or more at a time, to the grading and storage plant.

At the plant the trailers are raised by elevators about 50 feet where they are overturned, spilling their contents into a hopper.

6 Inside the husking and grading plant, employees at machines with conveyor belts grade the nuts after husks have been removed. The next containers are bins directly below where the pecans fall for the next step.

7 Large plywood boxes, which hold 1,800 pounds of graded shell pecans, are placed in storage rooms with a motorized fork lift prior to shipment to the packaging and processing plant. This warehouse is refrigerated and the nuts stored for prolonged periods are kept at an ideal $-10°$ F.

At the packaging and processing plant, are the nut cracker machines. Shells and meats are carried by conveyor to workers upstairs where they are separated by hand. Conveyors then carry meats to hoppers, which will return them downstairs for another grading and packaging.

8 Workers also make final inspection prior to bulk packing, making certain no shell fragments remain.

Highest grade pecan halves are sorted on another conveyor for Christmas package tins. These are the largest and best produced by Stahmann farms.

9 Anoher machine fed from above, drops shelled pecans of preset quantities into endless see-through bags. After the machine cuts, fills, and seals the bags, each one slides onto a belt which travels by a lady who checks their weight on a scale and puts them into cartons.

Stahmann farms consider their pecans to be quality products, and competitive in price. They are purchased from many consumer markets under an attractive trade name. # # #

YOUNG NAVAJOS IN TOWN

by W. L. (BUD) RUSHO,
Information Officer,
Salt Lake City, Utah

VISITORS to Page, Ariz., may be surprised these days to see young, clean-cut Navajo men and women in town, shopping in stores, mowing their lawns, or depositing money in the bank.

While they will also see other Navajos dressed in traditional Indian costume, the presence of the young Navajos is due to the coming of industry to Page. An electronic packaging firm opened its doors last July with an ambitious program designed both to earn a profit for the company and to assist the Indians.

The story of how this industry and the Navajos got together actually began years before, when this land of sun-swept rocks and sand was disturbed by little but the voice of the wind.

A dozen years ago Page, Ariz., did not exist. The low mesa on which the town now sits was visited only by occasional Navajos herding flocks of sheep through the sparse grass. Through the canyon below coursed the muddy, erratic Colorado River, so barren of life that it was called by the biologists an "aquatic desert."

The Bureau of Reclamation and the dam builders arrived in 1956. They were but the vanguard of a change that was to engulf the river, the land, and the Navajos. Glen Canyon Dam became the prime mover, the key facility around which repercussions were spun off like spreading circles from a rock thrown in water.

Page Was Built

First, the town of Page was built as an adjunct to the dam, where workmen could live, shop, and send their children to school. Although construction of the dam is now finished, the town continues to provide accommodations to operators at the power plant, to National Park Service employees, to businessmen, and to the teachers. In the last few years Page has grown as a tourist accommodation center.

The spreading circles of the dam's influence did not stop at the Page city limits. In 1957, nearby Navajos, so long isolated in the most remote part of their reservation, found they had a convenient city at the reservation border.

From the time the first store opened its doors, one could always find Navajos in Page. Some were products of white man's schools and were therefore "educated" in his sense of the term, but others, particularly the older generation, were true unsophisticates characteristic of the entire Navajo Nation 25 years earlier.

Isolated by mountains, canyons, and desert sands, and served by poor or almost nonexistent roads, people from this part of the reservation had lagged in adopting the white man's ways. In the early years of Page, many Navajo wagons were seen in town driven by men whose long black hair, wrapped in white string, protruded from beneath broad black hats.

Use Laundromat

Nowadays at the laundromat, rows of Navajo women, many dressed in full-length velveteen skirts, do the family wash, while nearby their babies sleep peacefully in cradleboards.

For neighboring Navajos, Page is an economic center, a place to purchase almost every necessity or luxury. The Page school system absorbs Navajo youngsters. When an Indian becomes sick he can go to a doctor or to the town's modern hospital.

During construction of the dam, many Navajo men worked for the contractor as highscalers, vibrator operators, and laborers. A point was made to hire an Indian wherever he was qualified for the job. (See article: "American Indians—Helping To Build A Nation," *Reclamation Era*, November 1962.)

Until recently, not many Navajos lived in Page. Since the whole reservation was open to them, they preferred to build a hogan or a small cabin within commuting distance.

Now that the construction work is finished, the future of Navajos in Page looks brighter than ever. This is due to the unusual cooperation between the

Two young Navajo ladies leaving their place of employment after a day's work.

Annie Benallie, right, receptionist at an office in Page, visits her friend May Betoney at her hogan 16 miles away, in the Navajo reservation.

Bureau of Reclamation, the Bureau of Indian Affairs, and the electronic corporation.

Building Available

Early in 1967, the Bureau of Reclamation, with a smaller office staff caused by completion of work at the dam, decided to move to new offices then becoming available in the Glen Canyon Powerplant. The large administration building in the center of Page was made available to the Bureau of Indian Affairs if that agency could find some use for it. Within a few months, the BIA located a client who would rent the building and who would hire Navajos to assemble uncommon devices—electronic modules. The company was located in Anaheim, Calif.

Suddenly, the space age had caught up with this land of stone, sand, and blue sky. Although the idea seems somewhat strange, having Navajos construct electronic parts has worked out well in practice. As Joe Guthrie, Manager of the electronics plant, says:

"Our company came to Page, and the Navajos, as a gesture of altruism and a desire for business success. Not only could we help the Navajos, but they are a stable work force when we have trained them."

The BIA pays for the on-the-job training, which usually requires 36 weeks. Since the work is fairly technical, a minimum of an eighth grade education is required for job applicants. At present, there are 24 Navajos employed, half of them women. Guthrie hopes to expand by stages until he has over 200 employees at the Page plant.

Citizenship

Training is in more than the mechanics of jobs. For instance, once a week Guthrie holds discussions with the Navajos on the responsibilities of citizenship—voting, keeping abreast of current events, and on participation in community affairs.

Jack Foster, left, senior lead man, assists Linda Silver, inspector, with final inspection of an electronic product.

Employees have their own recreation organization, for which they plan and arrange social functions.

Only two of the plant employees still live all year in the traditional Navajo dwellings called hogans. Some of them, however, return to the well-insulated and cool hogans in summer or for brief visits with relatives.

Does all this training in the ways of white men mean that Page Navajos are losing their tribal customs and beliefs?

"Yes, to some extent, Navajo culture is being replaced with white culture," says Guthrie, "but we cannot deny to the Navajos the advantages of a more healthful and higher standard of living."

Years ago, Navajo children who were given a white man's education often grew up to find themselves in a no man's land between two cultures and accepted in neither. Frequently, such a frustrated Navajo would "return to the blanket" and deny all knowledge of the white man's world, or he would seek the oblivion of alcohol.

In the Navajos working at Page, there is evidence that jobs in a typical "white" economy is no longer stigmatized by the problems of the past. One such man, Leo Sheppard, age 23, who hopes to become an architectural draftsman, has parents who live in a hogan, raise sheep for a living, and practice the Navajo religion. Leo states:

Visit Parents

"I take my wife and baby to visit my parents in their hogan quite often. I help with the sheep and do other chores, but my parents are happy to have me working in Page and are encouraging me to improve my education."

Last summer Leo took his parents on their first motorboat ride, a trip up spectacular Lake Powell. "They enjoyed the trip and still talk about it," Leo reports.

Annie Benali, who works for the BIA in Page, lived during her childhood near Glen Canyon. "To get water, we used to take our sheep down steep trails cut into the cliff to the Colorado River," she says. "When I was about 8 years old we moved, and I spent time in other parts of the reservation and in San Francisco. I first saw Page when I returned to this area in 1962. Now we have Lake Powell, new highways, and many tourists. I'm not sure I like all the changes, but I do appreciate the good roads and stores. I am now building a home on a hillside a few miles south of Page."

Joe Guthrie, who is partly credited for new opportunities for Navajos, is willing to meet them half way. He is learning the language of these Indians, one of the most difficult in the world.

"If my Navajo employees are willing to learn my language of electronics, I should be willing to learn theirs," said the Manager.

Guthrie summed up a situation of progress at Glen Canyon Dam, the town of Page, his company, and with the Navajos by repeating the traditional Navajo greeting, *Yá át ééh*, "It is good." (*Photographs by Mel Davis, Salt Lake City, Utah*) # # #

This 6-week-old Navajo baby is right at home in the traditional cradleboard. Pleased parents are Mr. and Mrs. Leo Sheppard who are like others from the reservation with homes in modern transa-houses at Page.

A trend, the start of evaluations, and an idea of the potential in underground waterways

Emphasis on Pipe

by **GUNNAR N. THORSKY,**
Chairman of OCCS Committee
(Photo on this page courtesy of United Aircraft Corp.)

IS there an emphasis on putting water conveyance systems into underground pipe?

Both emphasis and a trend are apparent. Just as other technologies change with time, developments in transporting water also change.

Water supplies are becoming more and more valuable, and losses must be reduced in its various distribution systems. To meet the challenges in this field, the Bureau of Reclamation has gradually shifted research emphasis from open conduit systems of carrying water to the idea of pipe, or the closed conduit.

It is evident that significant advances are being made in the manufacture and installation of pipe, and it is undisputed that its use results in smaller water losses than in open facilities. Regarding operation and maintenance, costs on open systems have been increasing.

Guiding Reclamation's research and development activities is the Committee on Open and Closed Conduit Systems which was established during the summer of 1967 in the Chief Engineer's office, Denver, Colo. Major role of the committee is coordinating studies on closed conduits, but they will also continue some work in the 21-year-old effort called the Lower Cost Canal Lining Program. It has made many contributions in lowering the cost of canal lining.

Advantages of Pipe

There are many other advantages in using pipe. It provides the possibility of constructing short routes in rough terrain. The pipe system prevents loss of water due to evaporation or phreatophytes. It has minimal seepage loss, fast response to operational demand, virtual immunity to variances in climate, and it requires less right-of-way land.

There is no loss of productive land which would have been occupied by an open system, and soil is not damaged by seepage. Weed cleaning and maintenance costs are lower, and water contamination is more easily avoided than in open canals. With drownings becoming a matter of increasing concern, pipe prevents people and animals from falling into flowing water and losing their lives by drowning as too frequently happens in open canals.

The OCCS Committee is starting to evaluate many such factors as those above in the economic study of pipeline systems. The foremost deterrent to the use of pipe, however, is its higher construction cost, under average conditions, than for an open lined system. Reductions in cost of maintenance, the value of water saved and other factors offset part of these costs, and the committee is coordinating a Bureau attack on this problem.

Reclamation engineer is taking a reading of instruments in an 18-inch steel pipe.

Pipe Testing

Five major types of pipe are being investigated. One is a half-mile test section of reinforced plastic mortar pressure pipe recently installed on a California project. Being monitored to determine field performance, this adaptation of a product used in the space industry to the water resources field shows much promise. Laboratory tests on commercial samples are also being made on this 15-inch diameter conduit. Other field tests have been initiated to evaluate large diameter pipe of this material, the effects of cold climate, and low covers.

Theoretical behavior of flexible steel type, having diameters of up to 30 inches, is being tested by applying pressures to it in a soil load box in the laboratory. Protective coatings and linings for this product are also being investigated as a continuing research program.

Sulfate resistance tests and soil burial tests are underway on a third kind of pipe. This is a small diameter, corrugated, perforated polyethylene drain type. Further development of filter theory and mechanized construction practices indicate the possibility of tremendous rewards in the field of plastic pipe for drainage. Liaison is being maintained with other agencies involved.

Specifications for reinforced concrete pressure pipe are being updated. These revisions are the result of tests, analysis, Reclamation's experience, and recommendations of industry.

The possibility of extending the size limits of the fifth major pipe—of asbestos cement materials—used on Reclamation projects is being investigated.

Also under study are pipeline joints, bends, valves, and devices and structures for measuring the flow of water.

Industry Helps

While Reclamation's contribution is in testing, evaluating, and analyzing new products, it is dependent upon the development of new materials and products of private industry. In fact most technical achievements in this endeavor will be the result of cooperation between the people whose activities are directly concerned with using water, contractors, manufacturers of material and equipment and Reclamation staff.

How much pipe will be used on future projects of the Bureau of Reclamation? This depends on the amount of funds available; however, the trend is clear.

Some 20,000 miles of drainage pipe in sizes ranging from 4 inches in diameter to 30 inches are estimated to be needed on foreseeable Reclamation projects in the future.

Mainly because of high maintenance costs of open unlined canals, more distribution systems with capacities less than 50 cubic feet per second (c.f.s.) will be constructed in pipe.

And because of safety problems on open canals, it is estimated that 500 miles of existing canals having capacities of 50 c.f.s. or less, 120 miles of 50 to 100 c.f.s., and 270 miles of 100 to 500 c.f.s. should be replaced with pipe.

More in All Sizes

An increasing demand for high value municipal and industrial water, in the West, also points to this need of more conduits in all sizes.

Presently the Bureau has under construction about 150 miles of pressure pipelines for water conveyance. The longest pipe system Reclamation has completed to date is 322 miles of both large and small pipe carrying municipal and industrial water to 11 cities in the Texas Panhandle.

Indicative of the trend towards large sizes is the distribution system for the 600,000-acre Westlands Water District in California, currently under construction. It will ultimately require 1,000 miles of pipeline in diameters up to 84 inches.

Such future projects as the Auburn-Folsom South Unit in California, the Southern Nevada Project near Las Vegas and the Garrison Diversion Unit of the Missouri River Basin Project in North Dakota will have combined requirements of hundreds of miles of pipelines.

Between 1970 and 1975, an estimated total of 2,000 miles of pipelines will be required on Reclamation projects. # # #

Snowmelt Efficiently Caught for Summer Use on Arizona Project

PROP Minute Men and Dams Get Water on Hand

Some reservoir action is evident in this scenic view of Stewart Mountain Dam, Arizona.

by BING BROWN, Senior Press Representative for SRP

THE Salt River Project's balancing act may never make Broadway, but last season's run can only be termed a success.

During the water storage months of January through May, the SRP walked a tightrope of suspense. Decisions on water control to be made would favorably, or unfavorably affect nearly a million people and about 250,000 acres of land in and around Phoenix, Ariz.

Setting the scene for this real-life drama were the record snows which fell across the Project's 13,000-square mile watershed, creating a potential water runoff far in excess of the capacity of the SRP's six storage reservoirs. Features of the SRP have been constructed or rehabilitated by the Bureau of Reclamation.

Suspense was heightened by whatever the unpredictable weather might be—would temperatures climb slowly causing a gradual runoff from the higher altitudes or would they rise rapidly creating a rapid runoff?

The featured performer was the Salt River Project. Job of the SRP staff was one of constant surveillance, seeking the slightest indicator which would foretell what the nature of the runoff would be.

As the water continued to pour into Project lakes, information flowed into Project offices. Around the clock data was received showing the snow depths throughout the watershed, water content of the snow, riverflow rates, lake contents, and weather conditions. Each valuable statistic was checked, evaluated, and incorporated in the ever-changing total picture.

PROP Committee

Overseeing the situation and making recommendations for handling the runoff was the responsibility of the 2-year-old Project Reservoir

Operations Program (PROP) Committee, which is comprised of six SRP specialists in watershed and reservoir operations.

Spotters throughout the watershed reported to the committee each change in the weather, the snow pack, and streamflow in their areas.

"This type of early warning system," explained PROP Committee Chairman Ezra Vines, "gave us a number of hours to verify any trend before the resultant change in runoff reached our lakes.

Salt River Project employees, Ken Vineyard, left, and John Wescott, check weight of snow in tube to determine the quantity of moisture in the snow—this helps the project predict potential runoff.

"For example," he continued, "it takes about 15 hours for water to flow the more than 30 miles from the Verde Valley into Horseshoe Lake—the northernmost reservoir on the Verde River. By spotting a change in the rate of flow of the river as it flowed through the Verde Valley, we had ample time to analyze the situation and make recommendations to the Project's top management.

"The upstream spotters," Vines said, "allowed us to determine if a particular increase was a momentary peak which would have little effect on the storage capacity of our lakes, or if it was the beginning of a real trend toward greater inflow."

Others Helped

In addition to the Project's own spotters, personnel from a number of other agencies, including the U.S. Weather Bureau, the U.S. Forest Service, Arizona State Highway Department, and Arizona Public Service Co., also forwarded information to the committee. In all, the SRP received information from more than 25 separate points on the watershed.

Augmenting the hour-by-hour reports were complete snow surveys made every 2 weeks by the U.S. Soil Conservation Service, and partial surveys made as required.

"The Project's obligation is to try to fill its reservoirs, thereby providing an ample supply of municipal, industrial, and irrigation water for the Valley," declared Vines. "Any unnecessary release of water would be a violation of that responsibility."

The PROP Committee's plan, if making releases from dams became imminent, was to try to make them at a small rate of flow for a relatively long period of time. This would permit more of the water to seep into the ground, recharging the water table.

January Survey

In late January, 1968, the snow survey showed that if average precipitation fell on the watershed through the remainder of the runoff period ending May 31, the Project's lakes would receive about 920,000 acre-feet. However, the Project could only handle, through usage and storage, about 700,000 acre-feet of runoff during the period.

The question came back to weather.

Would precipitation be normal? Considerably less than normal precipitation would be sufficient to fill the reservoir.

Would there be a sudden rise in temperatures, possibly accompanied by warm rains? If there was, much of the expected runoff would occur in a short period of time rather than being spread throughout the runoff period.

Could the weather be predicted accurately enough? Any great variance from predictions could force immediate reevaluation of the PROP Committee's recommendations.

As the days turned into weeks and the weeks into months, the PROP Committee's ability was at work. Six times indicators showed that runoff into the SRP's six reservoirs would make spilling imminent.

Releases of water from project dams soon finds its way into the Arizona Canal, shown above in the city of Scottsdale.

Followed Formula

Six times the PROP Committee, following its carefully established formula and operating procedure recommended the Project's management order small releases of water from the reservoir system. Six times the recommendation was accepted and residents of metropolitan Phoenix were treated to the rare sight of water flowing in the Salt River as it cut through the center of the Valley.

In all, the quantity released totaled slightly more than 100,000 acre-feet. At no time did the rate of release reach 5,000 cubic feet per second. (The river channel has been rated as capable of containing a flow of 82,000 cubic feet per second.) Only roads in the river channel were closed. Those with bridges or culverts remained open at all times.

Careful manipulation continued and on March 22, 1968, the Salt River Project's six reservoirs contained more water than ever before in the Project's history. With 2,024,000 acre-feet in storage, the lakes were at 98.4 percent of their maximum operating capacity.

Climax of Act

Here the Project's delicate balancing act headed for its climax. It could be upset in an instant by the weather.

But the vigilance and planning of the PROP Committee paid off. Once more the spotters reported trends. Once more the committee evaluated data. And again a small flow of water was released from Project reservoirs. Estimates were correct!

On April 16, storage in the reservoirs peaked at an unbelievable 2,043,000 acre-feet—99.33 percent of maximum operating capacity. As the runoff period ended June 1, 1968, the Project would have set still another record. Storage would total about 1,985,000 acre-feet, an excess of 35,000 acre-feet more than ever before on that date.

For the Salt River Project, it was another statistical achievement. For the six members of the PROP Committee it meant even more. During the past 5 months they had given uncounted hours, day and night, to the cooperative project effort. Now they could point with pride to its successful conclusion. # # #

Farmer Builds Rock Picker

You have heard of cottonpickers and peapickers, but awhile back on the Eugene Zeigler, Jr. farm we ran into a rock picker—the first of its kind as far as we can find out.

The rock picker was designed and built by Eugene's dad, Mr. E. W. Zeigler, Sr., who owns an adjoining farm, on the Columbia Basin Project, Wash.

This rock digger and picker consists of two pronged magnesium forks attached to the power boom of a standard backhoe tractor. Each of the forks can be operated separately. After the forks are pushed into the ground beside the rock to be removed the operator closes the forks around the rock and lifts it out of the ground.

Mr. Zeigler says they have removed rocks weighing up to approximately a ton with the machine, but that anything over about 1,500 pounds must be pushed and pried out rather than lifted.

The invention came about because much of the 122 acres in the younger Zeigler's farm was filled with large submerged rocks. Removing them by conventional methods would have been very difficult and costly. Therefore, during the winter Zeigler went to work in his shop and came up with this useful machine, which, incidentally, has a patent pending.

Zeigler's earlier experience as a welder and machinist on heavy construction jobs came to his aid in designing the equipment. The picker now being used is essentially the first model tried, although some reinforcement has been added to make it capable of lifting the larger rocks.

In the hands of a skilled operator (Joe Rogers in the photograph), removing the rocks is done quite speedily. The Zeiglers estimate that in a week and a half they cleared about 30 acres of around 80 percent of the rocks present. After the rocks are laid on the top of the soil with the picker, a truck and loader haul them to a nearby borrow pit.

Mr. Zeigler says the cleared land, which has quite a good loamy soil, will be planted to dry white beans as soon as the clearing is completed. The owner also hopes that some of the land that is now nonirrigable can be reclassified and become eligible for some of the project's irrigation water. # # #

Crew Wins at County Fair

Beautification programs pay big dividends, and if there is doubt in your mind about this, better check with the crew at Black Canyon Dam on Payette River, near Emmett, Idaho.

A few feet of area between the recently constructed warehouse and the power substation fence was a problem of unsightly weeds and rocks—until a retaining wall was built and topsoil hauled in. Then there was the problem of what to grow there.

Because the Bureau of Reclamation takes pride in practical things, it was decided to try tomatoes and watermelons, neither of which are in the surplus crop category. Also with an eye on a higher degree of beautification, gladiola in various colors, marigold, and for sentimental reasons, a little sagebrush were planted.

Not just some, but much of this gardening effort

paid off. To prove that their Reclamation products were appreciated at the Gem County Fair, a photographer caught a pose of Wilbur Currier, Powerplant Superintendent, showing off the five ribbons while proudly standing in the lush growth of the garden. First place ribbons were awarded for pear tomato, klondike watermelon, and a pink gladiola. Second place ribbons were awarded for Texas watermelon and a red gladiola. Dividend: $2 prize money.

Oh yes, and one surplus commodity—free gardening advice. # # #

Cleaning Off Algae

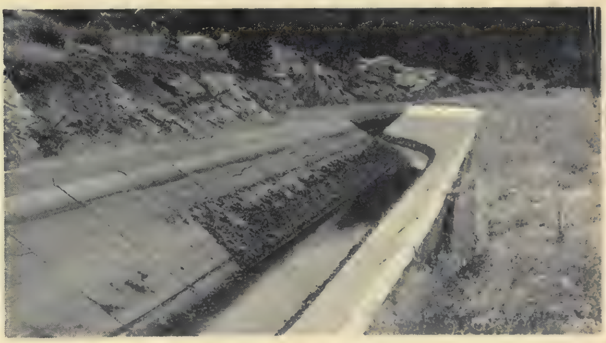
Green algae, or microscopic plants, will thrive year-around and form on the banks of some canals when water flow, sunlight and nutrients are sufficient to maintain growth.

Once each year, Pole Hill Canal on the Colorado-Big Thompson Project, Colo., is drained and the accumulation of dead algae is cleaned from the concrete lined slopes. The accumulation on the bank caused a serious cleaning problem prior to the fabrication of a special scraper and a sweeper.

Because the algae scrapes off easier when water-soaked, the cleaning operation should begin as soon as possible after the canal is drained. The disk scraper consists of 12 blades in two rows of six each of the type used on a farm disk machine. Each of these are attached to a rectangular metal frame with a bolt and coil spring. The scraper does its work when lowered over the side of the canal with a chain, then drawn back and forth by a pickup truck on the top of the bank.

After scraping, it usually takes about 24 hours for that portion of the algae still adhering to the concrete to dry sufficiently for brushing with the sweeper. The sweeper consists of a row of 14 wire brushes, size 7¼ inch, and a row of six fiber bristle stable type brooms, size 16 inch, mounted to a wooden frame. # # #

Top Photo. The scraper does its work when pulled along the side of the canal. The next step is brushing as seen in the center photo. At bottom is a before and after scene.



Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW.
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Fairgrounds, Fairview Ave. & Orchard St.
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
P.O. Box 15011, 2929 Fulton Ave.
Sacramento, Calif. 95813

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (Sw tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6538	Nam Mun and Nam Chi, Thailand.	May 15	Feasibility investigations, studies, designs cost estimates and reports. (Negotiated Contract)	Harza Engineering Co. Chicago, Ill.	$971,211 and equivalent of $111,860 in Thai currency.
DS-6596	Southern Nevada Water, Nev.	Apr. 10	Eleven motor-driven turbine-type pumping units for pumping plant No. 1, Schedule 1.	Layne and Bowler, Inc. Memphis, Tenn.	$755,383.
DS-6596	Southern Nevada Water, Nev.	Apr. 10	Eleven cone valves and one valve operating system for pumping plant No. 1, Schedule 2.	Guy F. Atkinson Co., Willamette Iron and Steel Co. and Bingham Pump Co. Divisions Portland, Ore.	$232,724.
DC-6600	Central Valley, Calif.	Apr. 25	Construction of Pleasant Valley pumping plant, discharge line and switchyard.	C. R. Fedrick, Inc., and M. M. Sundt Construction Co. Novato, Calif.	$5,231,253.
DC-6605	do	Apr. 2	Replacement of control equipment for Contra Costa canal pumping plants No. 1, 2, 3 and 4, and construction of switchyards No. 1 and 4.	City Electric, Inc. dba Trans-Pacific Electric, Inc. Menlo Park, Calif.	$279,371.
DC-6612	Central Valley, Calif.	Apr. 26	Construction of 6.3 miles of concrete lined Pleasant Valley canal, 1.6 miles of intake channel and structures.	Clyde W. Wood & Sons, Inc. Burbank, Calif.	$2,819,186.
DC-6613	Missouri River Basin, S. Dak.-Neb.	Apr. 5	Construction of 118 miles of Fort Thompson-Grand Island 345-kv transmission line, Section 1, Parts A and B.	Commonwealth Electric Co. and Dominion Construction Co. Lincoln, Neb.	$5,337,924.
DC-6619	Central Valley, Calif.	Apr. 23	Construction of a fish trap and modifications for Red Bluff diversion dam.	S & Q Construction Co. South San Francisco, Calif.	$360,127.
DS-6620	Missouri River Basin, S. Dak.-Nebr.	Apr. 26	Four 345-kv autotransformers for Fort Thompson, stage 05, and Grand Island, stage 01, substations, Schedule 1.	Hitachi New York, Ltd. New York, N.Y.	$925,664.
DS-6620	do	Apr. 26	Two 50,000-kva shut reactors for Fort Thompson, stage 05, and Grand Island, stage 01, substations, Schedule 2.	Federal Pacific Electric Co. Newark, N.J.	$279,180.
DS-6621	Missouri River Basin, S. Dak.-Nebr.	Apr. 30	Two 230-kv and three 345-kv power circuit breakers for Fort Thompson, stage 05, and Grand Island, stage 01, substations.	Ets Merlin & Gerin. Grenoble, France.	$496,500.
DC-6623	Chief Joseph Dam, Wash.	Apr. 22	Replacement of spillway and modification of crest of Conconully dam.	Equipco Contractors, Inc. Ephrata, Wash.	$533,057.
DC-6624	Columbia Basin, Wash.	Apr. 22	Construction of 26.8 miles of earth-lined laterals and wasteway and 3.6 miles of unlined wasteways and drain, Block 25 laterals, Wahluke Branch canal and laterals and Wahatis wasteway.	Equipco Contractors, Inc. Ephrata, Wash.	$1,270,366.
DS-6625	Colorado River Storage, Ariz.	May 10	Four 345-kv series capacitor banks for Glen Canyon-Pinnacle Peak transmission line.	Westinghouse Electric Corp. Denver, Colo.	$1,661,768.
DC-6627	Central Valley, Calif.	June 3	Construction of 5.6 miles of pipelines for Bella Vista Water District.	Glen W. Shook, Inc. Redding, Calif.	$240,424.
DC-6628	Gila, Ariz.	May 6	Construction of pipelines for South Gila Valley unit distribution system, Schedule 4.	M. M. Sundt Construction Co. Tucson, Ariz.	$757,965.
DS-6630	San Juan-Chama, N. Mex.	May 6	Four 4-foot by 6-foot outlet gates for outlet works at Heron dam.	Steward Machine Co., Inc. Birmingham, Ala.	$210.876.
DS-6631	Central Valley, Calif.	Apr. 2	Furnishing and installing one new armature winding for existing generator unit 3 at Folsom powerplant.	Westinghouse Electric Corp. Denver, Colo.	$192,588.
DS-6632	Central Valley, Calif.	May 24	Furnishing and installing one new armature winding for existing generator unit 5 at Shasta powerplant.	National Electric Co., Division of McGraw-Edison Co., Columbus, Ohio.	$230,573.
DC-6633	Chief Joseph Dam, Wash.	May 13	Enlargement of Spectacle Lake dike and outlet works.	A & B Construction Co. Helena, Mont.	$280,512.
DC-6634	Missouri River Basin, Nebr.	May 3	Construction of 124.3 miles of Fort Thompson-Grand Island 345-kv transmission line, section 2.	Commonwealth Electric Co. and Dominion Construction Co. Lincoln, Nebr.	$6,067,578.
DS-6637	Southern Nevada Water, Nev.	June 7	Twenty-three motor driven, centrifugal-type pumping units, 23 cone valves and four valve operating systems for pumping plants No. 1A, 2A, 4 and 5.	Hitachi New York, Ltd., New York, N. Y.	$920,300.
DS-6642	Columbia Basin, Wash.	June 12	One 230-kv power transformer for Grand Coulee powerplant.	Federal Pacific Electric Co. Newark, N. J.	$112,085.
DS-6647	Columbia Basin, Wash.	June 7	Repair of two power transformers for Grand Coulee powerplant.	Westinghouse Electric Corp. Denver, Colo.	$147,714.
DC-6648	Kendrick, Wyo.	June 20	Repairs to Alcova dam spillway	Etlin Peterson Construction Co. Mills, Wyo.	$320,547.
100C-977	Columbia Basin, Wash.	Apr. 1	Construction of 17.4 miles of buried pipe drains for D77-78, -78-1 and -114 drain systems, and D77-114-1 and -114-2 drains, Block 77.	M & J, Inc., Moses Lake, Wash.	$328, 852.
100C-979	Columbia Basin, Wash.	Apr. 4	Construction of 10.5 miles of buried pipe drains for D19-10 and D19-133A drain systems, Block 19.	Digger Dan and Sons and Pfaff Brothers, Inc., Moses Lake, Wash.	$138,183.
100C-987	Columbia Basin, Wash.	Apr. 17	Construction of 9.2 miles of buried pipe drains for for D20-114 drain system, Block 20.	Equipco Contractors, Inc., Ephrata, Wash.	$162,535.
100C-989	Columbia Basin, Wash.	Apr. 26	Construction of 15.5 miles of buried pipe drains for D46-24, -36 and -41 drain systems, Blocks 45 and 46.	Equipco Contractors, Inc., Ephrata, Wash.	$264,224.
200C-712	Central Valley, Calif.	June 6	Surfacing of O&M roads along San Luis canal, Reaches 3, 4 and 5.	Huntington Brothers, Napa, Calif.	$699,162.
300C-275	Colorado River Front Work and Levee System, Calif.	June 21	Constructing and surfacing 4 miles of haul roads, surfacing existing roads, and placing riprap for bank protection for Palo Verde and Cibola divisions.	C. W. Bailey, dba Bailey Engineering, Marysville, Calif.	$179,906.
400C-365	Colorado River Storage, Ariz.	Apr. 26	Extension of Glen Canyon airport runway	Nielsons, Inc., Doloras, Colo.	$229,229.
400C-372	Weber Basin, Utah	June 3	Construction of 4.3 miles of closed pipe and .3 mile of open drains for Farmington area "A" drains.	R. C. Tolman, Centerville, Utah	$146,088.
500C-263	Pecos River Basin Water Salvage, N.M.	Apr. 8	Clearing 630 acres of phreatophytes from Pecos River flood plain, Lake Arthur area.	Bates, Inc., Albuquerque, N.Mex.	$187,600.
603C-73	Missouri River Basin, N. Dak.	Apr. 22	Construction of office building, shop and warehouse building, garage, and oil house for O&M headquarters.	Scherr Construction Co., Valley City, N. Dak.	$214,904.

U. S. GOVERNMENT PRINTING OFFICE : 1968 O - 308-859

RECENT BID REQUESTS

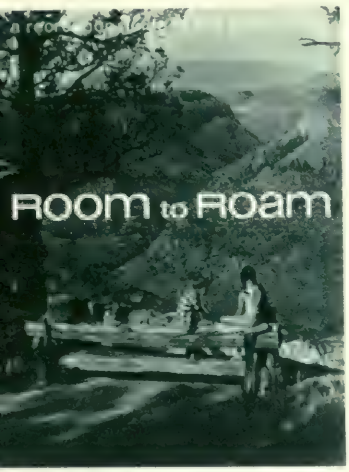
Project	Description of work or material
Central Utah, Utah.	Constructing two dams and one dike, all earthfill structures. North Dam will be about 53 ft high, 475 ft long, and will contain about 107,000 cu yd of material. South Dam will be about 69 ft high, 600 ft long, and will contain about 147,000 cu yd of material. The dike will be about 11 ft high, 790 ft long, and will contain about 8,800 cu yd of material. Appurtenant features will include a combined spillway and outlet works structure, a feeder canal, and an access road. The combined spillway and outlet works structure will consist of a 3-ft inside-diameter pressure conduit, a combined spillway and gate structure, a downstream 4-ft modified horseshoe conduit, a stilling basin, and a Parshall flume. The feeder canal will consist of a turnout structure, about 1,700 ft of open canal section, about 450 ft of 36-in. precast concrete pipe chute, and a stilling basin structure. The access road will be about 2,700 ft long. West of Fort Duchesne.
Central Valley, Calif.	Constructing about 17 miles of earth dikes with an average height of 5 to 6 ft throughout the 1,300-acre reservoir area; and earthwork and structures for about 23 miles of concrete-lined open drain having a bottom width of 8 ft and a lining height of 10 ft. Kesterson Reservoir, First Stage, and San Luis Drain to Mile 105. Five miles east of Gustine to 2.5 miles southwest of Dos Palos.
Do	Extending Tehama-Colusa Canal section about 760 ft; constructing about 950 ft of 18.5 ft-diameter siphon under Thomes Creek; and constructing 6,000 ft of dike along Thomes Creek. About 15 miles south of Red Bluff.
Do	Constructing 41.4 miles of 12- through 96-in.-diameter pipeline with heads varying from 25 through 125 ft; four slide gate structures; and two reinforced water screen and recirculating structures. Westlands Laterals 27 and 28, near Mendota.
Do	Clearing, earthwork, culverts, fencing, guardrail, and bituminous surfacing for about 2.8 miles of 40-ft-wide relocated county road. Auburn-Foresthill Road, about 1 mile north of Auburn.
Do	Preconsolidating 3.5 miles of lateral and two pumping plant sites. The preconsolidation will be done by sprinkling, ponding, and ponding with infiltration wells. Westlands Water District, about 12 miles south and five miles west of Mendota.
Do	Constructing 19 pipe crossings for Interstate Highway No. 5 which will consist of 6,200 ft of 18- through 60-in.-diameter pipe for 300 ft of head. On Interstate Highway No. 5, from 10 to 60 miles northwest of Kettleman City.
Chief Joseph, Wash.	Construction two small pumping plants of reinforced concrete. The Whitestone Flats Plant will have a capacity of 17 cfs with three pumping units and about 850 ft of 27-in. buried discharge line. The North Branch Plant will have a capacity of 9 cfs with two pumping units and about 105 ft of 18-in. discharge line. At Spectacle Lake, about 7 miles northwest of Ellisford.
Columbia Basin, Wash. (Third Coulee).	Constructing a 200- by 45-ft structural-steel framed building with a garden level reinforced concrete basement. Building exterior walls are to be brick with a window wall and insulated panel system covered with aluminum sun screen. Work will include electrical, plumbing, heating, and air-conditioning installations. About 1 mile east of Grand Coulee.
Do	Constructing a 58- by 85-ft reinforced concrete visitor center building. The building will be partially buried in a hillside with earth backfill on the roof and on three sides. Work will include electrical, plumbing, heating, and air-conditioning installations. Adjacent to the left powerplant road at Coulee Dam.
Columbia Basin, Wash.	Placing about 7.5 miles of concrete lining and buried pipe in the W3F lateral. Block 70, east of Soap Lake.
Do	Constructing about 30 miles of buried pipe drain. Block 46, east of Othello.
Do	Constructing about 22 miles of buried pipe drain. Blocks 18 and 47, west of Connell and east of Othello.
Do	Constructing about 19 miles of buried pipe drains and a pumping plant. Block 75, south of Quincy.
Do	Constructing about 15.1 miles of buried pipe drains. Blocks 20 and 85, west of Basin City and North of Royal City.
Do	Three single-phase, 400-mva, 500/230-kv autotransformers for Grand Coulee Third Powerplant.
MRBP, No. Dakota.	Constructing Killdeer Substation will consist of constructing a 20- by 20-ft concrete masonry service building; concrete foundations; furnishing and erecting steel structures; furnishing and installing one 110/41.8-kv, 3-phase power transformer, two 46-kv oil circuit breakers, two 115-kv interrupter switches, one 115-kv horn gap switch, eight 46-kv disconnecting switches, and associated electrical equipment; and grading and fencing the area.
MRBP, Iowa	Stages 04 and 05 additions to the Creston Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing one 161/69-kv, 50,000-kva autotransformer, one 16,200-kvar shunt capacitor bank, one 161-kv and three 69-kv power circuit breakers, and associated electrical equipment, major items of which will be Government furnished; and grading and fencing the extension to the existing substation.
No. Platte, Wyo	Two 5,000-kva, 3-phase, 34.4/2.3-kv transformers for Guernsey Powerplant.
Parker-Davis, Calif.	Constructing about 65 miles of single-circuit, 3-phase, 161-kv Parker-Blythe Transmission Line will consist of clearing right-of-way; furnishing and constructing wood-pole structures; and furnishing and stringing three 954 MCM, ACSR conductors and two overhead ground wires. Extending from Parker to Blythe.
Pecos River Basin Water Salvage, New Mexico.	Clearing phreatophytes along the Pecos River Basin in the Avalon area from McMillan Dam to the Pecos River flume. Near Carlsbad.
Southern Nevada Water, Nevada.	Constructing Southern Nevada Pumping Plant No. 1, a 600-cfs, 20-unit plant consisting of a reinforced concrete substructure; a superstructure of precast concrete wall panels and columns and prestressed concrete roof beams; one 45-ft-diameter, 46-ft-high reinforced concrete surge tank; one reinforced concrete anchor; one encased special bend; one 120-in. flowmeter; and 3,225 ft of 120-in.-diameter monolithic or precast concrete pipe with heads varying from 50 to 125 ft; and a switchyard. Work will also include installing 10 motor-driven, vertical-shaft, two-stage, turbine-type pumping units, and 10 hydraulic cylinder-operated, 24-in.-diameter cone valves; and furnishing and installing a 40-ton crane. Six miles north of Boulder City.
Do	Constructing Southern Nevada Pumping Plant No. 1A, a 315-cfs, 10-unit plant consisting of a reinforced concrete substructure; a superstructure of precast concrete wall panels and columns and prestressed concrete roof beams; and a switchyard. Work will also include installing 10 pumping units with electric motors and horizontal, centrifugal-type pumps. Constructing a 5-million-gallon, reinforced concrete, two-compartment forebay. The forebay is to be trapezoidal in cross section with reinforced concrete slab cover supported on circular columns. It will have a sand and gravel underdrain system, an emergency wasteway which will spill into a 54-in.-diameter reinforced concrete pipe running about 0.25 mile to Lake Mead. Attached to one end of the forebay will be reinforced concrete inlet and outlet structures and a wash water pump structure with two 96- by 120-in., two 120- by 96-in., one 108- by 108-in., and one-96- by 96-in. cast iron slide gates with motor-operated lifts. Six miles north of Boulder City.
Do	Constructing 7.2 miles of 36-in.-diameter, reinforced concrete pipe with heads varying from 50 to 575 ft; 0.4 mile of 27-in.-diameter, reinforced concrete pipe with heads varying from 50 to 175 ft; reinforced concrete Surge Tank No. 5, 12 ft in diameter and 92 ft high; reinforced concrete Surge Tank No. 7, 10 ft in diameter and 39 ft high; and air valves, blowoffs, anchors, and manholes. Boulder City Lateral, from 6 miles north of Boulder City to vicinity of the water treatment plant in Boulder City.
Do	Three horizontal, double-section, side-inlet, centrifugal pumping units with a capacity of 5 cfs at a total head of 80 ft for Pumping Plant No. 7.
Do	Three horizontal, double-section, side-inlet, centrifugal pumping units with a capacity of 9.6 cfs at a total head of 190 ft; and three 12-in. hydraulic cylinder-operated cone valves with valve-operating system for Pumping Plant No. 3. Three horizontal, double-section, side-inlet, centrifugal pumping units with a capacity of 34.5 cfs at a total head of 175 ft; and three 20-in. hydraulic cylinder-operated cone valves with valve-operating system for Pumping Plant No. 6.
Yuma, Calif	Earthwork and structures for about 5,800 ft of concrete-lined Seminole Lateral. About 2 miles northwest of Yuma.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.



U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management

DISCOVER AMERICA

ROOM to ROAM

Here is a planning guide to adventure, a handsome book in full color for anyon traveling or hoping to travel through the West and in Alaska. It has more tha 40 photos, six detailed regional maps, and 457 travel attractions, all brief described. There's something for nearly everyone; this 32-page book range through the Western outdoors from the Great Plains to the Pacific Ocean, fro the Southwest to Alaska. 1968.

Color photos and maps. 457 travel attractions. / 50 cents a copy.

.a guide to the Western Outdoors for people on the...go

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

losed find $................ (check, money order, or Supt. of Documents coupons). Please send me ....
ies of ROOM TO ROAM, *at 50¢ per copy. (Catalog No. I 53.2:R 53)*

ase charge this order
my Deposit Account
. ...

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DOC
____Enclosed________
To be mailed ____later________
____Subscription________
Refund________
Coupon refund________
Postage________

FOR PROMPT SHIPMENT, PLEASE PRINT OR TYPE ADDRESS ON LABEL BELOW, INCLUDING **YOUR ZIP CODE**

. GOVERNMENT PRINTING OFFICE
IVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFF

Name ....

Street addres ....

November 1968

RECLAMATION era

A WATER REVIEW QUARTERLY

November 1968 • Vol. 54, No. 4

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER. If the fishhook is as loaded as the determined poses of Mac, with bread wrapper around broken foot, and David, who peers 'neath nose-low hat—Treadway brothers of Gunnison, Colo.—even a wary Blue Mesa lake fish might lose his cool under such persuasive powers.

United States Department of the Interior
Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 30 cents (single copy). Subscription price: $1.00 per year (25 cents additional for foreign mailing).

COMMISSIONER'S PAGE

No Ghettos

Over a million rural Americans a year—though little prepared for the change—migrate to our already congested cities to add to the problems of inner city decay.

Rural America also reveals a strong appeal. A recent poll showed a marked increase over just the last two years in the number of urbanites and suburbanites who would prefer to live in small towns or on farms. Because this reverse migration is productive and relieves troubled conditions, its results are noteworthy.

Some of these moves have been in areas of western multipurpose water projects developed by the Bureau of Reclamation. Water control features and wise use of western rivers have paved the way for stable economies and attractive rural and small town living in the Reclamation sectors of the West.

These projects create personal cooperative relationships between people, the land, the community, churches, schools and business enterprises. By their very nature, growth of smaller communities and family-sized farms are encouraged.

Reclamation projects have meant a steady source of irrigation water which allows farmers to diversify their operation and take full advantage of their land. The projects have meant new water and power to support new industries and new towns. They have created scenic lakes which are popular for a variety of recreation uses and have encouraged tourist travel and use.

There are no depressed areas, no ghettos, no decaying inner cities on Reclamation projects. But there are many kinds of opportunities for those who seek them and will make the most of them.

Floyd E. Dominy
Commissioner of Reclamation

1 water supply system which is a
:redit to its direct beneficiaries,
Colorado, and the Nation as a whole

"STARTLING changes have taken place," is the anniversary theme of the 30th annual report of the Northern Colorado Water Conservancy District.

"Farming practices of 1938 bear little resemblance to the operations of today. A way of life disappeared . . . a way remembered with nostalgia but which had to yield to increased economic pressures for more and more efficiency," further describes the NCWCD's tone of progress.

Created by the Colorado Legislature in 1937, ours is the first such district ever organized. It also was the first to enter into a water repayment contract with the U.S. Government, and the first to be served by a wholly supplemental water project.

The large and productive NCWCD is served by the Bureau of Reclamation's multiple-purpose

Displaying the size and quality of sugar beets he grows on his farm is Henry Ashenbrenner of Longmont, Colo.

30 Years with the "BIG-TOM" Showpiece

by J. R. BARKLEY, Secretary-Manager, Northern Colorado Water Conservancy District

Colorado-Big Thompson Project, which is a showpiece of operational design in transmountain water diversion.

Construction on the "Big Tom" began in 1938 and—curtailed during World War II—its first limited water deliveries were made in 1947.

Supplemental water supplies to more than 00,000 acres of irrigated lands, to various municipalities, industries, and rural domestic water users' associations are provided by the "Big Tom." Flowing via the 13.1-mile-long Alva B. Adams tunnel, an average 260,000 acre-feet of water is diverted annually from the Colorado River on the western slope of the Continental Divide, located north of Denver.

Total costs of construction of the project were $163 million.

Cost Repayment

By contract, the District is obligated to return $29 million of the construction cost to the Federal Government over a 45-year period, including a 5-year transitional water rental period which began in 1957. The remainder of the project cost will be repaid from power revenues.

The NCWCD area embraces 1,481,000 acres in Boulder, Larimer, Weld, Morgan, Washington, Logan and Sedgwick Counties. The first valuation of the District in 1937, was $120.8 million. In 1966 it had grown to $493.5 million, and for 1967 it had climbed to $546.3 million—the latter 1-year increase of more than 10 percent.

However, both the number of farms and the farm population have decreased. Thirty years ago, 6,400 irrigated farms supported a farm popula-

Barley is given a March planting in this field near Berthoud, Colo.

tion of about 40,000 people in the District. Today the number of farms is 4,000 and the on-farm population dropped to 17,000.

Meanwhile, the average size of the irrigated farm more than doubled—from 97 acres to more than 180 acres during that period. Approximately one-half as many people are now operating two-thirds as many farm units and producing vastly greater quantities of farm products from the same total acreage.

For the farmer and livestock feeder, this change is not as rosy as it might appear. While the dollar value of crops produced in the District rose from about $26 million in 1938 to about $95 million in 1967, the purchasing power of the dollar sank by 50 percent or more. Then, too, prices the farmer and feeder must pay for essential goods and services went up much more than the prices he now receives for his products.

Explosive Growth

After World War II, the rapid growth of the American economy and the almost explosive growth in population created rising demands for every commodity on the market. Increased demand for meat and meat products, especially beef, was no exception. In 1938, the value of sheep and cattle fed for market within the District was a little more than $18 million. Today, that value is at an annual rate of more than $250 million.

The market for livestock feed created by the feeding industry, plus the economic factors previously mentioned, resulted in significant changes of cropping patterns within the District.

In 1938, 195,000 acres, or almost one-third of the harvested irrigated land within the District, was used for small grain production. In 1967, only about one-tenth of the total irrigated land, or 71,000 acres, was used for this purpose. Corn acreage for grain and silage jumped 400 percent, and alfalfa hay acreage increased from 147,000 to 180,000 during the same period.

There were also significant acreage changes for other important crops not directly related to the livestock industry. For example: Sugar beet acreage decreased from 107,600 to 75,200; dry bean acreage increased from 42,000 to almost 65,000 and potatoes declined from 31,000 to 22,000 acres.

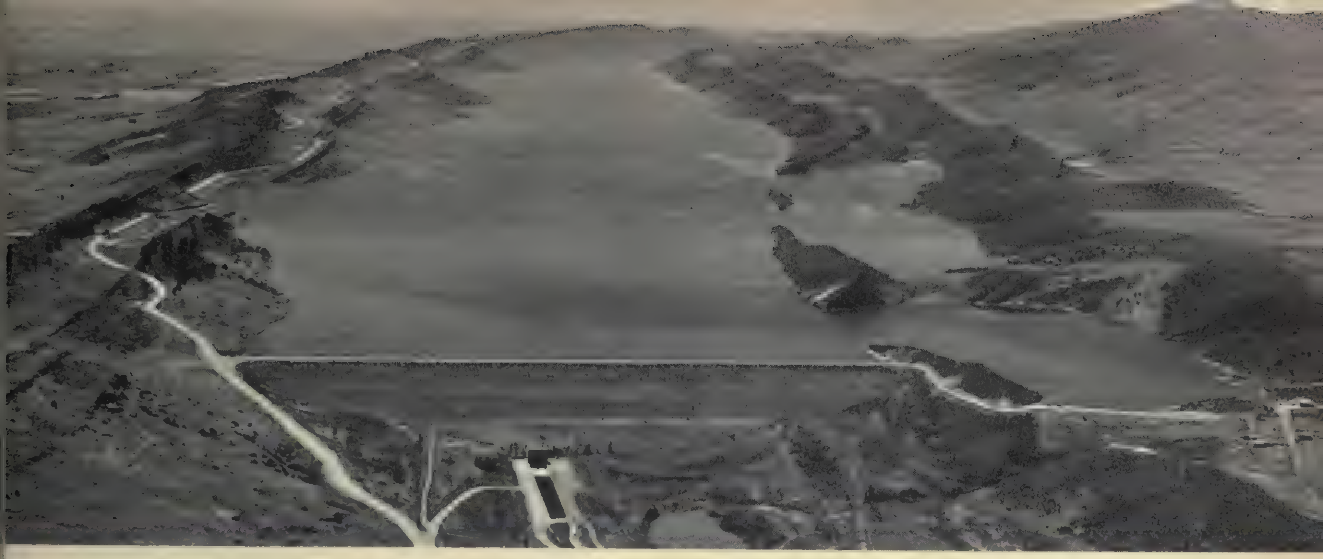
With the shift in crop acreage, there was also a marked increase in yields for most crops.

The use of more fertilizers, improved seed, better equipment, plus improved cultivation and irrigation techniques were all factors that helped the farmer increase his efficiency.

212 Percent

Average yields for the major crops grown in the District increased during the 30-year period by as much as 212 percent. These crops include corn for ensilage, corn for grain, alfalfa, irrigated dry beans and sugar beets. The increased yields and the shift in irrigated acreages could not have taken place without an increased and more dependable water supply.

Development of a stable water supply was, of course, the reason for the creation of this District and for the construction of the Colorado-Big Thompson Project.



Horsetooth Reservoir is cradled between lofty mountain walls behind Horsetooth Dam.

What accounts for the sharp acreage increase ı some crops and the decline in others?

First, a number of crops are more adaptable to rigation than are wheat, oats, and barley. These nall grains thus were largely relegated to the olling foothills areas. Much of this is land of ninner soils and less productive than the land the east.

There are three reasons for the phenomenal in-rease in corn acreage for grain and silage:

1. The introduction and improvement of hybrid orn which matures adequately in 110 to 140 days r use as ensilage;

2. The mounting demand for ensilage by the vestock industry;

3. A new and unique arrangement between the vestock feeders and the farmers.

To fulfill his feeding requirements, the feeder ontracts with the farmer to grow X number of res of corn at X dollars per acre. With seed ırnished by the feeder, the farmer plants, irri-ates, and cultivates—and then he has no further sponsibility. Through his own agronomist, the eder picks the time to cut the corn for ensilage.

ıvoring Corn

However, corn does not require the labor needed sugar beet production. Beet growers also con-act with sugar companies but they are paid by eight and sugar content—and also must supply e cultivating and harvesting equipment, as well the labor and seed. Another factor favoring corn that farmers can follow corn with corn while successive annual plantings of sugar beets on the same ground has not proven successful.

There's a twist of irony here because it was the sacred sugar beet that really developed the area. Also, corn was a dirty word only a few years ago, nationally, when the United States had a surplus.

Sugar beets were introduced in what is now southern Colorado in 1841—35 years before the State was admitted to the Union. The Great Western Sugar Co. was organized in 1900 by Charles Boettcher of Denver. Five years later there were six sugar factories in the District.

Other contract production is carried on with canneries for such vegetables as peas, sweet corn, cucumbers, tomatoes, potatoes, and snap beans. Moravian barley also is being grown under contract with a Colorado brewery.

The history of the once lowly pinto bean is interesting. Once a dryland crop, it was a staple of the farmer, section hand, cowboy, sheep herder, and poor city dweller of the west and southwest. During the chili and bean soup days of the drought and depression of the 30's, it was discovered that the crop responded miraculously to an occasional irrigation.

Pinto beans today are regarded as a profitable irrigated crop in the District and production is fantastic. A dryland yield of 15 to 20 bushels per acre was considered good; production under irrigation regularly ranges from 70 to 80 bushels per acre, and the beans do not require as much water per season as do corn or sugar beets.

Almost no poultry is now seen on farms in the District but the commercialized poultry business

is thriving in a specialized form. If you live in Boston, Baltimore, or Seattle, it is not unlikely your holiday turkeys, as well as your T-bone steaks, come from the land just east of the Colorado Rockies.

Business Records

It is human nature to resist changes, and farmers are no exception. In the past 20 years, farmers have been compelled to improve their managerial ability in order to stay in business. It wasn't too long ago that farmers were keeping their books and crop records on the two-by-fours in the barn.

Nor does it seem very long ago that our farmers conducted their own "eyeball snow surveys" by

Operation of a meat packingplant in the project city of Greeley, Colo.

watching the glacial notch in Longs Peak, a towering sentinel on the Continental Divide. When the snow in the notch disappeared, they stopped irrigating the alfalfa and thereafter reserved all the remaining water they had for row crop finishing.

With imported supplemental water and with the improved water supply forecasts of today, of course, we can advise them in April just about how much water they can expect in August.

It is only fair to note that it has been the individual adaptability to farming changes which has contributed greatly to the present production levels within the District and made it possible to produce, from 1951 through 1967, a total gross crop value of nearly $1.5 billion—over eight times the project construction cost.

The availability of water—while fluctuatir both up and down somewhat—has lured thousan of people and many new industries into tl District.

More Uses

Although the original quest was for suppl mental irrigation water, our repayment contra with the United States also specifies that tl water may be used for domestic, municipal, ar industrial purposes, as well as for the productio of electric power.

Eleven cities now receive part of their munic pal water from the project as a means of bolste ing their in-basin water supplies.

Between 1950 and 1960, the population of a seven of the counties within the District increase by more than 45,000—from 207,230 to 252,300. Tl 8-year increase since 1960 is estimated at mo than 50,000.

Certainly, there have been more dramatic po ulation jumps in other U.S. areas, but it must l remembered that this area was formerly almo purely agricultural land that measured its su cess by the rain guage and not by the number shopping centers.

Pacing the urbanization is the university ci of Boulder whose population spurted from 20,0 in 1950 to an estimated 55,000 today. Boulde Fort Collins, Longmont, Greeley, and Lovelar together have experienced a population increa of 43 percent in the last 8 years—from 110,3 in 1960 to an estimated 158,000 today.

A new development since 1960 has been tl formation within the District of 14 rural dome tic districts or associations to which we furni raw water for treatment and distribution as rur domestic supply.

Chief among the new industries is a huge IB plant near Boulder with 4,200 persons on the pa roll. The plant manufactures magnetic tape ar magnetic tape drives. Products of other man facturers, attracted to the area, range from plast toys and hydroponic tomatoes to cement and aer space components.

Few To Cities

Yes, people are moving off the farm, but fe here are heading to the troubled major cities. Mo have found the good life in the smaller commun ties where there is space to work and play. Ma of the newcomers, in fact, are people who work

he Denver metropolitan area. There may be a esson here in planning programs to relieve poverty, racial strife, and other ills of our current U.S. civilization. A three-bedroom house with double garage to accommodate a boat is commonplace fulfillment to thousands who have come here from he big city jungles. The formula is basic: adequate water plus productive soil equals the production of new wealth and a stabilized or growing economy.

Up to now, comparatively little of the richest agricultural land has been taken out of production to achieve the rapid urbanization. Land along the foothills, though less productive, has greater appeal for the homebuilder who is more interested in vistas than in vegetables.

Original allottees obtained their water allotment contracts at no cost. Ordinances published by the municipalities today—30 years after this District was created—reveal that the cities have paid the agricultural users as much as $150 per contract acre-foot to achieve the described allotment contract transfers.

Actually, the ability to transfer water from one locality to another, anywhere within the District, and to change the class of water usage are, of themselves, factors which contribute to the asset value of District allotments.

In summary, it is my personal and humble opinion, that the Bureau of Reclamation constructed, and the District operates, a system for water supply distribution in a manner which is a credit to

This is Longmont and adjoining fields with Longs Peak, the highest in view with elevation 14, 256 feet.

Increased Demand

It is obvious from the urban, rural domestic, and industrial growth which I previously cited that there is an attendant increase in the demand for water supplies to fulfill those purposes. Although the quantity of water allotted by the District for those uses has more than doubled since the early 1950's, nearly 80 percent of our total water supply remains allocated to irrigation usage.

To retain the greatest possible flexibility in system operation and to permit water supplies to be shifted to new and changing uses, the District adopted procedures which allow amendment and transfer of allotment contracts. Thereby a method was established which allows municipal, domestic and industrial water users to obtain project water allotments by transfer from agricultural uses.

both agencies. In addition it is a source of new wealth for its direct beneficiaries, the State of Colorado, and the Nation as a whole. # # #

ABOUT THE AUTHOR. *For 10 years J. R. (Bob) Barkley has been Secretary-Manager of the Northern Colorado Water Conservancy District. During this time, and for 25 years leading up to that appointment, his talent and energies in water resources matters have been plied to use in and beyond the borders of Colorado. Mr. Barkley was Chief Engineer and Assistant Manager of the NCWCD for 13 years. He recently was appointed as Colorado member of the Board of Directors of the National Reclamation Association, has served in other advisory capacities of that organization, as well as with other organizations having to do with water resources in the Missouri River Basin. He is a registered professional engineer in the State of Colorado.*

Wrestled for years with bad water problems—now hope is on the way

Water for Coalinga

by JOYCE HOFF, Sacramento, California

PEOPLE in Coalinga will soon need only two faucets at their kitchen sinks instead of three. They now have taps for hot and cold water, but they are using a separate one for drinking water.

It looks clear and sparkling and even tastes all right, but the water in Coalinga, Calif., is full of boron and other salts, sulfates and minerals. It is harmful to drink.

By December of 1969, however, Coalingans will have good quality water from the Pleasant Valley Canal now being built by the Bureau of Reclamation as part of the San Luis Unit of the Central Valley Project.

Coalinga is a town of 7,000 in Fresno County. Its name was "Coaling Station A" when, around 1887, oil shale deposits there were used as fuel for railroad locomotive fire boxes.

Before "Coaling A" was incorporated, essential good water was wheeled in by horse-drawn water wagons and delivered to the homes. Most people had 80-gallon barrels in their front yards to hold it. Later on, this water was brought in from the town of Armona 40 miles away by railroad tank cars, but it was still delivered by wagons to the individual houses.

Pipelines were laid for delivering the hard water in 1922, and pipelines for delivering potable water for the third water faucet were laid in 1931.

At Railroad Station

Also, at the Railroad station it was "pump-it-yourself for 10¢ a bucket." Even today, farmers buy water from the old station for 7¢ a cubic foot (a penny a gallon).

In 1917 the city built a small water tower and pumped water into it from the railroad tank cars. During this same year the first of the wells which produce the hard water was drilled in the city. Today the wells are 1,300 feet deep, where the standing water level is at 270 feet. The pumps are set at 500 feet. Since 1958 the water table has dropped 80 feet.

In 1959, Ionics Inc. installed for Coalinga the first municipal electrodialysis plant. The plant takes the salts out of the water and softens it, making it safe to drink. This furnished enough water to meet the needs of the city—28,000 gallons a day—until the city began to grow as a result of San Luis Unit construction.

Then UCLA put the world's first municipal reverse osmosis desalting plant in Coalinga on an experimental basis, producing 10,000 gallons of good quality water a day. This method uses a series of pipes with a membrane inside the pipes. Water is forced through the membrane at high pressure, causing it to permeate the sides of the membrane, leaving the salts and bacteria inside the membrane.

The good water costs 7¢ a cubic foot, with a minimum of $1.75 for 25 cubic feet. Occasionally a family will run up a monthly bill as high as $350 because of an undetected leak in a pipe.

Predicted Ghost Town

Eighty years ago crewman on the train which brought in water to Coalinga predicted that the town would become a ghost town since it didn't have its own supply of good water. But Coalinga has survived and grown, mainly because the area around it had large reserves of oil, the world's largest deposit of asbestos, the Nation's largest supply of commercial chrome ore, plus cinnabar, gas, magnesite, manganese, gypsum, and mercury.

Residents of Coalinga do not need to fetch their drinking water from this water service station, but others who live out of town do.

It also has the only supply of aggregate on the west side of the San Joaquin Valley which meets State and Federal specifications for reinforced concrete.

Most of the minerals are considered by the Department of the Interior to be of national importance, but they have not been developed substantially because of the brackish water that eats away at machinery, pumps, and valves. Also, asbestos companies which use the wet process for their asbestos can't use the brackish water.

The oil fields at Coalinga are about 60 years old—some of the oldest in California. They have lost their pressure and the oil remaining is heavy. About 20 percent of the oil has been pumped out. Were it not for the corrosive water an additional 40 percent could be taken out by pumping steam into the wells, thus making the oil movable. Without water from the Pleasant Valley Canal now under construction, the oil companies would be forced to abandon the wells.

"Housewives will be just as happy as the oil companies to get good quality water," according to Glenn H. Marcussen, Coalinga's city manager and engineer. "They have to soften the water to wash clothes. Even then the water is so hard on washing machines that they last only a couple of years.

Hard Water Troubles

"Water faucets dissolve. You can't wash windows with the hard water; it etches them. Service stations can't even use it to wash car windows. If you get some of the water on your house while watering your lawn, it makes the paint on the house turn white. There isn't even a commercial laundry in Coalinga because of the water problem."

In addition to the cost of water, it costs another $20 a month for a small house and $30 to $35 a month for a large house for maintenance needed due to the hard water.

Farmers in Coalinga have been persistent. Using naturally available waters for irrigation, they can grow salt-tolerant crops such as cotton and melons and have developed ingenious ways of protecting the seeds and roots. It has been found possible, for instance, for row crops to grow when the seed is planted half way up the mound. Even some farmers have put seeds in capsules to protect them from the salt until they get a start. Even then, it is difficult to grow vegetables and there are many plants that just won't grow with the water that has been available in the area. Apricot trees last only 3 or 4 years before dying from salt damage and willow trees won't grow at all.

In 1966, 10,000 acres of canning tomatoes were grown, but they had to be trucked to Stockton and other towns to be canned because of a lack of suitable processing water near Coalinga. There are 5,000 acres in an area where semitropical fruit can be grown, with good water.

Coalinga's good water will come from the Bureau's San Luis Canal. An intake channel about 1½ miles long will take water from the San Luis Canal to a pumping plant where it will be lifted 180 feet into the Pleasant Valley Canal. The city will pump water out of the canal into a filtration and water treatment plant, then 20 miles of pipeline will take the water into Coalinga.

Cost of Works

The city's water works will cost over $5 million, $2.3 million of which will come from a grant from the Economic Development Administration. Another $2.8 million will come from municipal revenue bonds. When the city voted for the bonds, they were favored 1,973 to 34.

The Pleasant Valley Canal will be over 11½ miles long when completed and will range in capacity from 1,100 cubic feet per second at its beginning to 350 cubic feet per second at its southern terminus. Work has begun on the first reach—scheduled for completion the end of 1969. This 6.3-mile-long canal will be concrete-lined and have a bottom width of 12 feet. Besides providing water for Coalinga, it also will furnish irrigation water to Pleasant Valley farmers and to a portion of the Westlands Water District.

Third tap is to turn on water for drinking and cooking. It won't be needed when Pleasant Valley Canal is completed. This is Mrs. Lou Niboli.

The pumping plant is being constructed of concrete, brick, and steel, will be 193 feet long and 71 feet wide. It will have nine 1,250 to 7,000 horsepower pumping units. A switchyard is being constructed next to the pumping plant. Construction costs for the pumping plant, a discharge line, and the switchyard will be approximately $10.3 million.

Coalingans plan to start pumping from Pleasant Valley Canal on the first day water is available in that structure. Shortly thereafter they probably will have a contest to decide what to do with the third water faucet that will be useless in every home.

With water, Coalinga should become a booming city, as the Interstate 5 freeway, which will connect Coalinga with northern and southern California markets, is being built nearby, and as oil lines, gas lines, and 500,000 volt transmission lines serve and go through the area. New industries will soon be moving in, and houses will be built with only two faucets per sink. # # #

Recreationists will now enjoy better scenery and facilities

Recreation Sites Improved by Job Corps

BOAT launching ramps, camp and picnic areas and various other recreation facilities have been built at scenic reservoir sites in seven Western States by the Jobs Corps Civilian Conservation Centers administered by the Bureau of Reclamation.

People from the communities near the attractive new recreation developments have publicly demonstrated appreciation to the young Job Corps men for their efforts. Highlights of the State programs, which are still going forward at seven centers on Reclamation's multipurpose water development projects, include:

California.—Completion of 28 picnic sites and other facilities at the Judge Carr Memorial Park on the shores of Whiskeytown Lake near Redding. Construction of the only boat launching area yet developed on Lewiston Lake in Trinity County. Construction of the 28-unit Junction City Campground on Trinity River, Trinity County. Development of parking, access routes, and picnic sites at Fisherman's Point near Shasta Dam. Completion of eight family units at Old Man Campground on north shore of Shasta Lake. Addition of eight family campsites and several picnic sites to Douglas City Campground.

Idaho.—A 54-acre recreation area, with 10 acres of beach and a 50-unit modern campground, is under development at Lake Lowell, southwest of Caldwell, Idaho. Twelve modern campsites are under construction and other improvements are in process at Marsing, Idaho's Island Park on the Snake River.

Nebraska.—Heavily-used camping and picnic facilities have been developed at the Macklin Bay recreation area on Swanson Reservoir west of McCook. Picnic sites, access roads, utilities and parking areas also were completed at Hugh Butler Lake, north of McCook. Roughly 100,000 seedling trees were planted at four Bureau reservoirs and 30 acres seeded to grass.

Oklahoma.—At the Buckhorn Recreation Area, Arbuckle Reservoir, near Sulphur, 509 picnic tables, 254 fireplaces, and 222 trash stations were

nstalled on 50 cleared acres at an appraised value of $53,600. A breakwater, boat ramp, parking area, ınd service area were constructed at Guy Sandy Recreation Area, Arbuckle Reservoir, at an appraised value of $107,500. Job Corps trainees also ompleted an attractive concrete-stone bridge at Platt National Park, also near Sulphur.

Utah.—Picnic facilities, including tables, grills, nd shelters, have been completed at one marina nd are well underway at Willard Reservoir, in orthern Utah. At the East Canyon Reservoir, east f Salt Lake City, roads, parking areas, shelters nd comfort stations have been completed and additional facilities are planned. Many smaller projcts, such as water systems, access roads and trails, eseeding, and erosion control, also have been ompleted by trainees.

Washington.—On May 17, 1968, recreation acilities valued at $80,000 were dedicated at Sumner Falls Park on the banks of Billy Clapp Lake. The newly-completed facilities include a 5-acre icnic area, parking for 200 cars and boat trailers, oat ramp and utilities. A trash fish barrier was nstalled in the Gloyd Seeps area. A 300-unit campround is under development at Potholes State Park at Potholes Reservoir, also in the Columbia River Basin. Center workshops have fabricated 00 steel picnic stoves, and 400 picnic tables for he Roosevelt Lake Recreation Area.

Wyoming.—Recreation areas have been completed at Cottonwood and Black Beach on the once remote south shore of Alcova Reservoir and at Pathfinder Reservoir, near Casper. Facilities completed include 141 picnic sites, 30 shelters, 62 fireplaces, 68 trash stations, four boat ramps and three boat docks, access roads and parking areas.

# # #

Graduate Job Corps youth, Robely George of Louisiana got this job on the tie gang of the railroad out of Ogden, Utah. Beginning pay is nearly $23 per day.

orpsmen from the Marsing Center olunteered to make a search for a st 2-year-old boy.

318-428 O - 68 - 2

A Tour at Shasta Dam

by NAOMI L. HUNT,
Washington, D.C.

WHAT is the fascinating story behind the Shasta Dam and Powerplant?

Curious about this massive monument to progress, Mr. and Mrs. Lawrence W. McClure with their two children, Karen and Kenny, from Red Bluff, Calif., took the self-guided audio-visual tour through Shasta Dam.

Last May, as they stood before the dam's spillway, which creates a waterfall three times higher than Niagara Falls, they were awed by its proportions. They went deep inside the dam, 67 feet from the upstream face and over 400 feet beneath its crest.

Passing through its eight tour stations, the McClures walked along the galleries inside the structure. At the specially designed stations they could hear tape-recordings over a loudspeaker. They saw topographic maps, colored slides, and other interpretive devices.

The large welcome sign at the first tour station included a drawing of Shasta Dam and Powerplant and presented the structure as the "Keystone of the Central Valley Project." The recorded voice introducing the tour was started by a button mounted low enough on the board for young Kenny McClure to push.

The McClures looked on as the narration added statements of interest about the three visuals at that station.

Purpose of Shasta

The construction of Shasta Dam demonstrates man's desire and ability to control his environ-

ment. Built as a barrier to tame the Sacramento River, the dam is 9 miles north of Redding in the heart of Shasta National Forest.

Torrents of water from cascading mountain streams pour into Shasta Lake during the rainy winter and wet spring. This water is stored and distributed throughout the year through a series of dams and canals, and is pumped nearly 500 miles to the southern tip of the thirsty San Joaquin Valley in the south.

The Sacramento River changed from a capricious stream which sometimes burst its banks, and sometimes barely trickled, into a year-round navigable waterway with near-ideal conditions for spawning and survival of ocean-going fish. Devastating floods which in the past threatened the valley on the average of once every 4 years have been virtually ended.

From the river, irrigation water is furnished to produce crops extending from Redding to Bakersfield.

Construction of the Shasta Unit began in 1938. The dam is 602 feet high, base to top; 487 feet above streambed to crest of spillway. It is 3,460 feet long and 30 feet thick, at crest. Shasta's spillway, the central portion of the structure, is larger than six fooball fields; and contains 6.5 million cubic yards of concrete. It is a Bureau of Reclamation structure. The Federal investment of nearly $200 million will be repaid by water and power users.

At Station 2

The automated display at the second tour station featured the dam's five huge generators. Each of these awesome machines, which the McClures actually saw in operation, is rated to produce 83,662 kilowatts. Each is spun by 85 tons of water per second rushing out of 15-foot diameter penstocks. This powerplant generates enough electricity to fill the needs of a city of almost half a million people.

By lifting the children up to his height at station three portholes in the wall, Mr. McClure was able to give them a dramatic view of the outside of Shasta's five giant penstocks (pipes) which convey water to the turbines.

Visitors actually walk outside the dam at station four, where they are treated to a worm's eye view of the towering dam.

Back inside the structure at station five, the McClures find the lounge is a welcome feature, and the recorded voice provides more of the Shasta story while visitors are resting.

Shasta Lake—one of the largest manmade lakes and one of the most interesting and diversified recreational areas in the world—is formed behind Shasta Dam. It can hold enough water to cover 4.5 million acres to a depth of 1 foot; has 365 miles of shoreline; and is 35 miles long.

Because the flow of water from Shasta Dam is irregular, another dam forming Keswick Reservoir was built to store extra water, to meet power loads, and to regulate its flow into the Sacramento.

Some of the water in the river is used to meet needs in the Sacramento Valley; the rest is carried downstream to the Sacramento-San Joaquin Delta. At the delta, power from Shasta Dam is used to pump water into the Delta-Mendota Canal, through which it flows southward into the San Joaquin Valley.

Galleries and Tunnels

There are 4½ miles of galleries and tunnnels inside Shasta Dam. The self-guided tour of course, does not include all of the long, lighted galleries. But they are intriguing and the voice echoes from wall to wall. The McClures took one such tile or cement gallery en route to station six. Kenny laughed to hear the sharp echoes when he clapped his hands. At that point they were 428 feet beneath the dam's crest.

Station seven gives a close-up view of the power transformers, massive and imposing in appearance. They step up the 13,800 volts from the powerplant to 230,000 volts for transmission overland.

Station eight provides a view of the old diversion tunnel through which the Sacramento River had been diverted to avoid its interfering with the construction of Shasta Dam.

The principal function of Shasta Dam and the other facilities of this unit is to provide a dependable, ample, year-round supply of water. There are, however, many other benefits, including flood control, power production and recreation.

Through the summer the reservoir becomes a playground for hundreds of thousands of water recreation enthusiasts. Because of Shasta Lake's excellent fishing, boating and camping facilities, many resorts and service businesses have been established to provide for the need of recreation seekers.

Navigable River

The controlled releases of water also increase the Sacramento River's value as a navigable waterway. Commercial shipping on the Sacramento has increased threefold due to the steady supply of water from Shasta, which maintains the required depth of the ship channel.

Water for municipal and industrial use is another benefit resulting from this construction, particularly in the Contra Costa area.

Fish conservation, too, owes much to the regulated flow of cool water into the Sacramento River. Late each fall, thousands of king salmon, seeking their ancestral spawning grounds, head up the Sacramento River. Those that reach Keswick Dam enter a specially constructed trap, are raised to the top of the dam, and placed in a waiting tank truck.

The captured salmon are carried 30 miles to Coleman fish hatchery—built by the Bureau of Reclamation—where they are artificially spawned. The hatched offspring are cared for until they are large enough to be released to swim downstream and renew their life cycle. Thus Shasta Dam is helping to revive an important salmon fishery, valuable for both sport and commercial fishing.

The new self-guided tour at Shasta Dam is free and open daily. For 30 years, however, hundreds of visitors have been coming daily to tour this great multipurpose structure. They come to learn why it was built, how it works, and what it means to them. They come to be educated in modern water resource development and to be inspired as they stand before this major feat of engineering skill—a living monument to man's dreams and competence. # # #

TRAINING EXPERTS OF OTHER NATIONS

by CHRISTOPHER W. IVUSIC,
Washington, D.C.

AMERICA is a free Nation dedicated to the ideal of self-help, but it is also committed to fostering freedom and progress for peoples whenever and wherever possible.

In this spirit, the U.S. Bureau of Reclamation has built hundreds of water and power development projects in the arid and semiarid Western United States since the early 1900's.

In recent years, Reclamation also has sent more than 250 technical "missions" to some 54 countries in response to requests by foreign governments for technical assistance in water resources development. It has welcomed thousands of foreign professional and a few subprofessional men and women for training at Reclamation's offices, laboratories and field projects. And, since 1949, it has been host to visits of over 5,000 water resources engineers and specialists from foreign countries at these same laboratories and field installations.

Examining a core sample used in canal linings are, from left, Jean-Gustave Yameogo of Upper Volta, and Job Komguen of Cameroon, who once took foreign training at the Reclamation Engineering and Research Center.

Today, as in the past, Reclamation assists people in a dual role—one domestic and the other foreign—in creating beneficial water use programs which promise steadier, richer economies.

While training has been continuing and the results in improved use [illegible] resources are evident, some nations, which have high potential

nd critical need for the benefits of water manage-
ient, are not aware that they too can share in the xperience acquired in the 66-year-old Reclamation rogram. This is to let them know that such help ; available, and how to go about obtaining it.

earch for Growth

In the vast regions of the West, men and women f many nations and creeds settled and contributed) the amazing growth of the area. The Mormons 1 Utah and the Basques in Idaho, are two ex-mples. In a similar search for room to grow and xperience, Suleyman Demirel, a young engineer rom Turkey, came to this country to study with he Bureau of Reclamation as one of the first two rainees sponsored by the Marshall Plan.

Demirel learned how Reclamation projects ork, and he also discovered how Americans re-axed and made use of their free time. When he eturned to his homeland, Demirel had broadened is knowledge and outlook. Eventually, he became Prime Minister of Turkey, a position he holds oday.

For all young men and women who wish to learn ow water resources development helped make he American West possible, Suleyman Demirel ay serve as an example. There are four basic ays open for a foreign technician to receive train-ng by the Bureau of Reclamation.

First, if the foreign national lives in a country here there is an Agency for International De-elopment mission, he may ask his government to equest AID to arrange for his training by the J.S. Government. The AID mission will review he request and process it through AID/Washing-on. Upon approval of the application by Reclama-ion, funds will be transferred to the Bureau to ay the costs of training.

Second, the individual may request training hrough diplomatic channels. This request would e processed by the Department of State, under erms of the Information and Educational Ex-hange Act, Public Law 402, a landmark law in ostering international cooperation through tech-ical exchanges of personnel and information.

Under this law an individual may arrange hrough his own government to pay his way to the Jnited States, and his other expenses in order to earn a specialized aspect of water resources de-elopment, which will fit his needs at home.

Third, the foreign national may request a fellow-hip from the United Nations or from one of the several private foundations which work in economic development abroad. Such fellowships also are handled through the Department of State.

Personal Requirements

The requirements are that the foreign national be proficient enough in the English language to use and understand both technical and nontechnical terms. He (or she) must be of sound health, of good moral character and able to meet the security clearances, and visa requirements prescribed by the State Department. He must also be employed, or be a prospective employee, in a field of work in which the Bureau is engaged, and must be a graduate of an institute of higher education or qualified by other training and experience to carry out the proposed training activity.

Costs of such training or observation cannot be borne by the Bureau. The U.S. Congress appropriates money to the Bureau to plan, design, construct, maintain and operate projects in the United States, essentially in 17 Western States. By the sale of power and water to project users, most of

Land classifier Ivan Woodworth, with shovel, is discussing Columbia Basin project soils with Makham Liengphilavanh of Laos, and Pinit Mengveah of Thailand.

the money advanced eventually will be paid back to the Federal treasury. In view of this reimbursability, no funds are available in the Reclamation program to pay for the training of foreign nationals.

Guiding Hands

Once they arrive in the United States, a few participants in the Bureau's foreign training program have even learned how to square dance. But square dancing usually has to wait until the trainee gets out West. Initially, he reports to the Division of Foreign Activities in Washington, D.C. for orientation and a review of his training program.

The week of orientation is conducted at the Washington International Center, a private institution partially supported by AID. Here a friendly and guiding hand is extended. He is invited to American homes, goes sightseeing around the Nation's Capital, and is told about the nature of American government, school systems, religion, social customs, and other aspects of life here.

Coping with problems of language, climate, separation from his family, and possibly of wearing a different form of dress, the trainee frequently needs sympathetic understanding and time to adjust.

After 1 week in Washington, the trainee usually travels to Denver, Colo., a mile-high city located at the base of the snow-capped Rocky Mountains of the Continental Divide. At the Bureau's Office of Chief Engineer, the agency's engineering and research center, detailed training programs and field assignments are arranged. The training programs usually provide between 5 and 12 months for in-service *training* and up to 4 months for official *observation*.

The trainee is assigned to a selected office and/or field unit, and is given individual guidance and instruction that will best augment his background and experience. The guidance is provided by Bureau employees in conjunction with their normal duties.

May Attend Courses

Although the Bureau does not give classroom instruction, the trainee may be able to attend the Bureau's courses for its employees in concrete, engineering materials, land drainage, operations and maintenance, and land classification; the latter being taught at Colorado State University at Fort Collins, Colo.

Foreign nationals who come to *observe* Reclamation projects normally are experienced engineers and administrators. Office studies, combined with visits to field activities in project planning, design, research, construction, and operation, make up the major part of these observations.

One of the most vital subjects in the training activities, which ranges from dam and canal engineering to atmospheric water resources research, is instruction in project investigations. More and more throughout the developing nations of the world, money must be borrowed to plan and build water use projects. Economic justification studies must show how the proposed project will pay for itself. The Bureau tries hard to impress upon trainees that overall river basin planning—the multi-purpose concept of water development—is vitally important in this day and age.

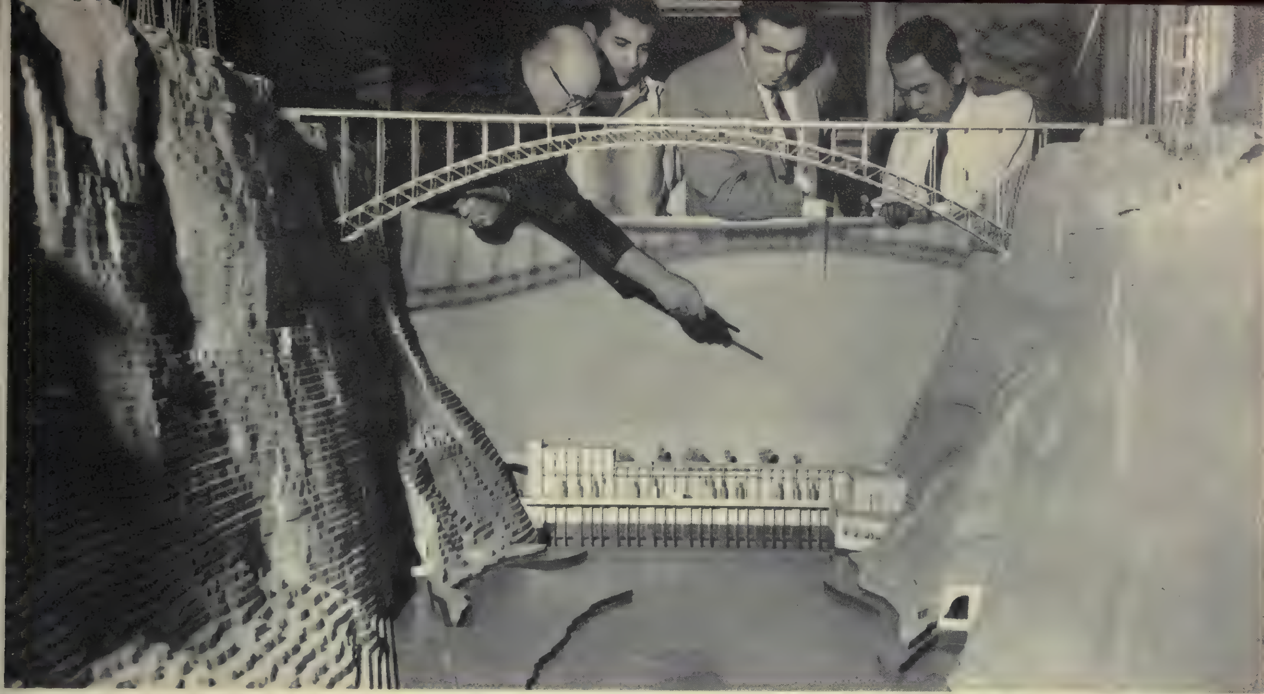
Reclamation projects in the United States especially the smaller multipurpose ones, generally are used to illustrate the many complex factors involved in water resources development. The Yuma Project in Arizona, the Weber Basin Project in Utah, or one of the Colorado River Storage Participating Projects, are among the projects used to give on-the-job training in the fields of power, irrigation and drainage, fish and wildlife conservation, municipal and industrial water supply, recreation—and all other aspects of multipurpose development.

Throughout his training, the participant is encouraged to see America and to enjoy its cultural, social, and economic benefits. For some this may mean a visit to the larger cities in the West, such as San Francisco; or simply making friends with people in our country.

Outstanding Trainees

One of the outstanding foreign trainees with Reclamation is David Chu from Taiwan, who was sent in 1953 to Reclamation's Billings, Mont., office for training at Canyon Ferry Dam and then to the engineering center in Denver. Mr. Chu returned home to work on a $110 million dam and reservoir project. He came back to the United States in 1961 to visit the American friends he had made in Billings, Mont.

Despite the fine example of Mr. Chu, it is not always possible for the Bureau to determine whether the participant will actually have opportunities to put his or her water resources education to work for their native land; nor is it possible al-



Demonstrating on a model of a dam (Glen Canyon) at the Denver center is Gilbert L. Brown. Trainees are Wiland Gundersund of Guatemala, Pedro F. Arroyo of Venezuela, and Kamol Chitakorn of Thailand.

ways to find out whether the participant has found a professionally satisfying role in the development of his country's water resources. The answer to both of these questions frequently must be delayed for several years due to the necessity for reorganization or reorientation within the home government, including recognition by those in authority in his home land of the ever-increasing need for water resources planning, and the urgency of starting the planning at the earliest possible date.

Nevertheless, the difficulty of determining post-training activity cannot dim the record of outstanding participants who have trained with Reclamation and then returned home to rise to positions of responsibility.

Some of these successful trainees and observers include: Neset Akamandor, who became Director General of Turkey's State Department of Hydraulic Works (DSI); M. L. Xujati Kambbu, Vice Minister of Development in Thailand; M. L. Jeongjan Kambbu, Director General, Royal Irrigation Department in Thailand; and Kasme Chatikavanij, Director General of the Yanhee Electric Authority in Thailand.

Other Leaders

Also, Julian A. Buendia, Chancellor of the University of the Philippines; Agapito Alano, Director General of the Department of Public Works (retired) in the Philippines; Tomas de Guzman, who became Director General of the National Irrigation Administration in the Philippines; and Mahmoud Gadein, former Deputy Minister of Irrigation and Power in the Sudan, and now an official of the African Development Bank.

Another outstanding trainee is J. Laginha Serafim of Portugal, now president of an engineering firm in Lisbon, who accompanied Commissioner Floyd E. Dominy and Associate Chief Engineer H. G. Arthur on their tour of African nations in October 1967. Mr. Serafim returned to the United States last May to visit his friends in Reclamation, and was escorted on a tour of the Bureau's Glen Canyon Unit by Commissioner Dominy.

Although meeting the technical needs of the men and women coming here to learn about water resources development is the primary goal of Bureau training, of almost equal importance is the instilling in each trainee of a sense of warm social acceptance and "belonging." We consider these people as friendly neighbors from developing nations. Reclamation personnel join the rest of the people of our country in wishing them wholehearted success in their struggle for peaceful relations, economic development; and progress in their part of the fight against poverty and hunger. # # #

Fisherman Ben Snyder puts another fish on his string.

Things being done by Colorado to maintain this large fish-stocked Reclamation reservoir

FISH VARIETIES AT BLUE MESA

by WILLIAM J. WILTZIUS

If you drove on Highway 50 between Gunnison and Montrose, Colo., last year, you probably already know about Blue Mesa—the long, narrow reservoir which impounds the famous Gunnison River and is the uppermost of the three reservoirs of the Curecanti Unit, Colorado River Storage Project.

It also is noted for being the largest lake—natural or man-made in Colorado. (Blue Mesa reservoir forms behind a dam of the same name constructed by the Bureau of Reclamation.)

But even if you didn't immediately pull off the highway and try your fishing luck, many questions probably came to your mind. What kind and how many fish had been stocked? Why? Were the fish growing well and what were your chances of catching them? What was being done to maintain this large fishery?

To gather data that would form the basis for the fishery management of Blue Mesa reservoir, as well as Morrow Point and Crystal reservoirs which together make up what is known as the Curecanti Unit, the Game, Fish and Parks Department initiated a preimpoundment research study in July of 1964.

This study was supported by Dingell-Johnson funds (¾ Federal, ¼ State) until July 1967. Since then, the funds have come from the section 8 monies, a totally Federal fund which, among other uses, allocates to participating States all finances for approved fishery investigations on the federally built reservoir units of the Upper Colorado River Storage Project. Curecanti, Navajo, Flaming Gorge and Glen Canyon are the largest units of this project.

Colorado's investigations at the Curecanti Unit have been concerned primarily with Blue Mesa reservoir because it was the first reservoir of the unit to be completed. However, since Morrow Point reservoir started filling early in 1968 and the construction of Crystal Dam may begin soon, fisheries investigations probably will continue for several more years at the Curecanti Unit.

Five Objectives

The more important objectives of Colorado's investigations have been: (1) To determine the species of fish and fish-food organisms present; (2) to determine the chemical properties of the water

Yonder picturesque backdrop at Blue Mesa Lake is Killon Craigs.

in the Gunnison drainage ; (3) to determine the availability and potential fish-spawning activity; (4) to determine the initial fish-stocking procedures for the reservoirs, taking into consideration the basic characteristics and operations of the reservoirs; and (5) to develop management plans for the reservoirs.

Preimpoundment investigations indicated that the waters in the upper Gunnison drainage were for the most part favorable for trout production. The greatest drawback, however, was, and still is, the enormity of well-established sucker populations. Suckers have long been the thorn in the fishery biologist's side. Generally, when a body of water contains large and rapidly expanding numbers of suckers, there is less food and space available for the trout each succeeding year with the result that trout members become progressively limited.

Fish Stocking

Fishery biologists usually prefer to poison the water and start anew. However, we do not have a selective poison for suckers, and this means that the trout would also be killed. On top of this, total kills of all the fishes are seldom realized, and the suckers are the ones that best survive the poi-

son. Fish eradication was deemed infeasible and uneconomical, but did we therefore, admit defeat to the suckers? No, not entirely.

Anticipating the heavy initial stocking plan for Blue Mesa, the Game, Fish and Parks Department made exceptionally heavy plants of legal-sized rainbows in the Blue Mesa site of the Gunnison River during the summer and fall of 1965. In addition, a plant of 50,000 kokanee fry was made in April 1965, but this plant is believed to have migrated downstream before the closure of Blue Mesa Dam. Just after the dam was closed in 1965, the department planted 328,150 rainbow fingerlings ranging in size between 2 and 5 inches. When the ice went off the reservoir in March of 1966, the stocking schedule was greatly accelerated. This acceleration was enhanced by the addition of federally reared rainbows to our State-reared fish. The plants were made when the fish became available, and by October 1966, almost 3 million fish had been planted (about 2,500,000 rainbow and 500,000 kokanee).

Growth was very good. Rainbows planted in October 1965 averaged about 11 inches 1 year later. Those planted in March and April of 1966 as 2- to 4-inch fingerlings were averaging almost 10 inches by October of that year. No samples of kokanee were taken during 1966.

Expecting Blue Mesa to continue filling, considerable stocking was again done in 1967.

Establishing Kokanee Runs

Only about 275,000 of the total kokanee stocked have gone directly into the reservoirs; the remainder have been planted in selected streams above the reservoir for the purpose of establishing annual fall runs to permit easier snagging for the fisherman, and to facilitate the collection of spawn by the department.

As you may know, kokanee, like other salmon, have a very strong tendency to return to the stream or location of their birth or stocking. Despite this homing tendency, we have found that natural reproduction of kokanee in Colorado is almost entirely prevented by heavy icing of the streams and turbid runoff in the spring. Consequently, the department has had to annually collect kokanee spawn to perpetuate the species.

Our entire egg source comes from the kokanee running out of Granby Reservoir to the Shadow Mountain Spillway on the Colorado-Big Thompson Project. Recently the demand for these fish has nearly approached our supply. Much of this, of course, was due to the stocking of Blue Mesa Reservoir, and we are therefore attempting to establish spawning runs there.

We have made plants of kokanee fry in both 1966 and 1967 in the Lake Fork of the Gunnison and the Cebolla River. During 1966, 75,000 fry were also planted in Beaver Creek just above Blue Mesa Reservoir.

Emphasis, however, is placed now, and will be in the future on the East River, an important tributary of the Gunnison River above Blue Mesa Reservoir. Located on the west bank of this river about 20 miles from the high water line of Blue Mesa, is Roaring Judy Hatchery, one of our newest units. In 1967, 500,000 kokanee fry and 100,000 fingerlings were released into the East River at the hatchery.

Can you imagine the excitement of fishermen in November and December 1970, and annually thereafter, when about 50,000 12 to 16 inch kokanee spawners start to ascend the Gunnison River, pass directly through the City of Gunnison, enter the East River at Almont, Colo., and proceed the last 2 miles of their 20-mile journey toward Roaring Judy Hatchery?

Of course, the magnitude and success of this run depends on adequate numbers of the fry reaching the reservoir, surviving and growing to maturity, and then returning. If successful, it certainly will be something to look forward to, especially for Gunnisonites.

What Can I Catch?

Before impoundment, rainbow and brown trout dominated the trout composition of the Gunnison River. However, natives and brooks were also present, so now a fisherman at Blue Mesa can catch any of these species. But, as only rainbow and kokanee have been stocked in the reservoir and in large numbers, your chances of catching the other species are quite slim. In fact, rainbows have made up about 97 percent of the catch at Blue Mesa in its first 2 years of existence. Browns have made up most of the remainder (1.4 percent).

Well then, where are those kokanee? Kokanee seldom show up in the fisherman's catch until they have grown to about 10 inches and have completed at least 2 years of life. Since the earliest kokanee plant of any significance was in April 1966, and the fish from this plant had grown to only about 9 inches by October 1967, is there still doubt why so few have been taken?

Many of you are probably thinking, "Weren't most of those 11 to 13 inch silvery, pink-meated fish that I caught at Blue Mesa last year, kokanee?" The answer is no! They were almost all rainbows. Coloration usually is a poor characteristic to identify fish species, because changes of color frequently occur. These changes may be hereditary, environmentally induced, or due to the maturing of the creature, just to name a few.

Often, changes in fish coloration are associated with the protection of the animal. For example, in a shallow trout stream, the fish are most vulnerable to predation from the shore or from overhead—man, bears, fish-eating birds, etc. These fish enhance their protection by developing colors on their backs and sides which blend more with the stream bottom.

Many Colorado fishermen still associate pink-meated, silvery fish as being only kokanee. It is certainly true that kokanee have such characteristics but so do the rainbows in Blue Mesa as do rainbows in other large reservoirs. The pink-meated condition is believed due to these fishes consuming large amounts of food items containing the pigment carotene.

This yellowish-orange pigment is prevalent in the plankton which both rainbows and kokanee primarily feed on in many large reservoirs. During the winter when plankton is most scarce, the fish flesh tends to be less pink.

The crossing of U.S. Highway 50.

Danger Below

In large, deep reservoirs where the fish are feeding in open water much of the time, they are quite vulnerable to predation by other fishes from below. Consequently, these reservoir fishes develop lighter bellies and sides which blend with the light penetrating from above. Their backs may be darker because of the added protection it affords from the overhead type of predation. Is it any wonder, for example, that the normally dark rainbows from Gunnison River became silvery a short time after being in Blue Mesa?

The best visible characteristics for distinguishing between rainbows and kokanee is found in the differences in their fins. The large fin on top of and in the middle of the fish's body (dorsal fin) contains many round black spots in the rainbow. The kokanee's dorsal fin has no spots. The tail of the kokanee is less spotted and more deeply forked than the rainbow.

Most reliable but more difficult, is counting the rays in the anal fin, the fin between the tail and the vent on the underside of the fish. Rainbows usually have 9 to 11 rays, but never over 12; whereas kokanee generally have 14 or more rays but never less than 13. Overall spotting of the body is not reliable since it may vary from none to many on either species.

About the Catch

Despite the harvest not equaling what we had anticipated, most of the fishermen at Blue Mesa last year had better than average results. Many limits were taken, but the average angler creeled 3.43 fish while fishing 4.44 hours—a catch per man hour (CPMH) of 0.77.

Most large reservoirs in Colorado seldom have an average CPMH of over 0.30 and the fish usually average slightly smaller than at Blue Mesa where they averaged 11.1 inches during 1967. On a monthly basis, fishing success at Blue Mesa was best during April and June when the CPMH averaged 1.18 and 1.04, respectively. The lowest CPMH of 0.58 was recorded during August, but August was also the month when the average size of the fish was largest (12.7 inches).

When you first start catching kokanee, rather than continuing trolling along aimlessly, circle around and troll several times over the area where you got your first strike or fish. The reason for this is that Kokanee are almost always in schools, and you can easily move right over or out of their area.

In the spring and fall when the waters are cooler, the kokanee probably will be feeding in the upper 20 feet of open water. However, in the middle of the summer they will seek the cooler depths, say 30 to 70 feet in Blue Mesa, and therefore, you must fish these depths if you expect to catch kokanee. Trolling slow, in a zig-zag fashion, or better yet, just drifting with the predominantly westerly winds, in areas between Center Point recreation area and the dam, should yield most of the kokanee at Blue Mesa in 1968.

The use of lead lines, rigged with popgear, snubber and worms is suggested. Similar rigs or spoons on regular lines being trolled slightly faster, will yield primarily rainbows.

Brown trout will enter the catch more frequently earlier in the spring and summer. Look for shallow areas containing an abundance of sagebrush which allows protection for the small sucker and fathead minnows that the browns will be feeding on. Some of the large rainbows may be here, too. The browns will be in very close to the shoreline; or if you fish from shore, you will probably spook them.

Cast Near Shore

The most productive method should be from boats within casting range of shore. Cast your lure almost hitting the shore and swiftly retrieve it for a short distance. Vary the retrieving speed constantly and work small areas of the shoreline in this manner several times. You will probably lose both lures and hooked fish in the sagebrush, but the action will be much faster and you will occasionally land a lunker. Best times for such activities are early in the mornings and evenings.

If you are exclusively a "fair-weather-sunshine" angler you will be missing some of the best fishing at Blue Mesa. Many of the larger trout have been caught between 8 p.m. and 2 a.m.

One of the preferred localities is the area near the main Gunnison inlet where large stone fly nymphs, commonly and erroneously called hellgrammites, drift into the lake from the river. These nymphs are immature forms which give rise to the famous Gunnison River willow fly.

True hellgrammites are immature forms which give rise only to Dobson flies and such flies are not found even in the upper Gunnison drainage. Call these stone fly nymphs whatever you like, but they are excellent trout getters. I do not recommend their use in areas any great distance from the inlets because they are not born, nor do they develop and hatch in waters other than swift-flowing streams.

Some Blue Mesa fishermen have consistently taken 2- to 3-pound trout in the inlets by simulating stone fly nymphs or small minnows with artificials such as the brown bear, gray goose, or longshank wooly worms of various colors. I prefer to use the gray goose and wooly worm tied on No. 4, 2X hooks, sometimes weighted. The lure is tied onto about 5 to 7 feet of 4-pound level leader.

Stringing Line

I then pass my spinning line through a small waterfilled plastic bubble and tie a small swivel to the line. After the leader is attached to the swivel and the fly wetted somewhat, the rig is ready to be fished.

Shortly after the sun goes down, I anchor my boat in the channel of an inlet over water 4 to 10 feet deep where the current is not swift enough to lose anchor. The bubble rig is cast directly upstream and allowed to sink momentarily. I quickly make three to five turns of the reel, pausing very briefly between each full turn. This is followed by very slowly and continuously retrieving the line for another five to eight turns. I then go back to the fast-jerking retrieve and alternate thereafter until the current moves the rig behind the boat.

If you do not keep a fairly taut line while retrieving, you will not feel the trout strike and will miss many fine fish. This, of course, is easier said than done, but if you master the technique, it will produce where other techniques fail.

One last tip for you fishermen—avoid being an excessive "spot changer." Some fishermen are under the impression that the fishing at Blue Mesa is always better in some spot other than the one they are fishing. They constantly move around the reservoir and spend most of their time in transit. The result is usually less time fished and fewer fish in the creel. The above does not apply to most trollers, but some tend toward racing to cover as much territory as possible. This accomplishes little other than the boat ride.

Up-to-Date Management

This year 100,000 kokanee salmon fry were released in a newly constructed channel between one raceway of Roaring Judy Hatchery and East River. Also schools of kokanee were located by using echo sounders and marked with bursts of fluorescent granules useful for tracking and learning the movements valuable for fishermen. Next year tiny radio transmitters will be attached to some kokanee in schools for that purpose.

Besides making the regular large plants of local rainbows and kokanee in Blue Mesa in 1968 and 1969, kamloops rainbows, silver salmon and mackinaw trout will be stocked in 1969. The kamloops strain is a good one because of their tendency for greater longevity, ability to establish spawning runs, and preferred habitat being that of the Blue Mesa reservoir.

Silver salmon and mackinaw trout will be stocked for the purpose of aiding in the control of rough fish and to add variety to the fisherman's creel. # # #

WILLIAM J. WILTZIUS, *a fisherman, has worked for the State Department more than 3 years. He is presently an assistant wildlife researcher stationed at Montrose and is involved in post impoundment studies on the Curecanti Unit in Colorado. We extend our appreciation for this article to author, Mr. Wiltzius, and* Colorado Outdoors *magazine, where it appeared in longer version in the May–June issue.*

Analyze Accidents

There are six main points in analyzing an accident. An accident causes:

1. Immediate lost time while getting an injured employee to first-aid treatment and several other employees may have to leave their jobs temporarily to render assistance.

2. If the injury is serious, production drops sharply because everyone has the accident in mind and can't give full attention to the job, and a bad accident may affect the work program for several days.

3. Something has to be done about the injured employee's work. A temporary replacement may be required.

4. If the employee's accident is serious, he may not be able to do his full job when he returns to work and a light work program has to be arranged. This will affect production and efficiency.

5. If you have to substitute a less experienced worker for a regular employees, he may damage expensive equipment or machinery and he, too, might have an accident.

6. A serious injury lowers the morale of other workers and it may change the attitude of the injured employee and reduce his efficiency after he returns to the job.

Can you stand to have these six things happen? If not, then there are things that can be done. Set up a safety program for your organization.

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW.
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Fairgrounds, Fairview Ave. & Orchard St.
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
P.O. Box 15011, 2929 Fulton Ave.
Sacramento, Calif. 95813

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (Sw tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

How it was done six decades ago

First Dam on the Wild North Platte

by NELLO CASSAI, Region 7 Information Officer

A 22-horse freighter hauling cement from the town of Casper, 45 miles to the damsite in 1907.

ON a spring day in 1909 a crew of common laborers could look at a mighty engineering marvel spanning a deep canyon in south-central Wyoming and say with pride, "We built that with our own hands."

Under professional guidance and with a minimum of primitive mechanical help, they had indeed.

Engineers today still gaze with awe at Pathfinder Dam on the North Platte River 47 miles southwest of Casper, Wyo., one of the first four or five dams constructed by the Reclamation Service.

Built of huge granite blocks extracted from nearby quarries, this masonry arch dam rises 214 feet from bedrock in the canyon floor and has a crest length of 432 feet. It tapers from a base width of 97 feet to a top width of 11 feet.

Unskilled immigrants and sons of immigrants bearing such names as O'Toole, Morelli, Weder, Kajutis, Geko and Moore alternately sweat and froze for about 35 cents an hour between 1905–09 to erect this unique structure, consisting of almost 55,000 barrels of cement and 60,210 cubic yards of masonry. The stone was hard, coarse-grained granite quarried within 1/4 mile of the dam.

Face stones were cut 2 or 3 feet thick and were laid in about 2 inches of mortar. The backing stones, irregular in shape, weighed up to 10 tons. It took a lot of prying and lifting to bed them properly and mortar them in place. The inner portion of the structure was filled with waste rock and mortar.

Water gushing through the rock at left, in this 1958 photo, was to be cut off after rehabilitation of the dam.

Rock for Dam

Narrow gage tracks connected cement sheds and quarry to the end of the dam and mixing house. There was a slight grade to the track and two men could handle a 10-ton rock from the quarry to the tramways which lowered the rock to the dam.

Pathfinder was the first dam built on the once-wild North Platte River in Wyoming by the Reclamation Service, now known as the Bureau of Reclamation. The dam and adjoining dike create a reservoir with a capacity of 1,016,000 acre-feet, almost exactly the size of Folsom Reservoir, Calif.

North Platte Project features presently in operation supply irrigation water for 335,000 acres in Wyoming and Nebraska. They also produce electricity, control floods, and provide significant outdoor recreation opportunities. Eight other Bureau reservoirs in the North Platte Basin have a combined storage capacity of 2,119,455 acre-feet.

The original plan, in 1902, was to build a storage dam at Devil's Gate on the Sweetwater River about 20 miles above its junction with the North Platte in Wyoming.

This natural site had been noted by the returning Astorians in the fall of 1812 and it later provided a passageway in the trade route to the West beyond the Rockies.

Surveys, however, revealed that the Sweetwater did not supply enough water to justify construction of a big dam at that point.

In 1903, State Hydrographer A. J. Parshall, of Wyoming, reported to Chief Engineer F. H. Newell of the Reclamation Service that there was an excellent dam site in the "Big Canon" just below the junction of the Sweetwater and the North Platte.

The ordinary traveler was not aware of its existence because the Oregon Trail passed some distance north of the canyon.

Lt. Fremont

Some said the "Great Pathfinder" Lt. John C. Fremont, had passed through the canyon in a boat and had lost his surveying instruments in the river near the present Pathfinder Dam.

At any rate, the Reclamation Service established a diamond drill crew at the dam site August 1, 1903. However, boats and roads had to be built first and then machinery lowered into the canyon. The drill work was slow and costly, principally because the drills were mounted on boats which, although firmly anchored and tied, could not be prevented from surging. This presented a danger of crushing the diamonds.

In February 1905 the Reclamation Service awarded a contract for construction of a diversion tunnel—even before plans for the dam were completed.

The tunnel, 480 feet long, was worked from two headings with crews laboring 11½ hours per shift. All drilling initially was done by hand but soon four electric drills were installed and later two steam drills were added. The best average daily progress for a full week was 5½ feet per day for one heading.

The two headings met on May 21, 1905, but 2 days later the spring runoff flooded the tunnel and deposited 2 feet of silt.

This was the first of many incidents that marked construction of Pathfinder, a pioneer development which proved a useful field laboratory for the infant Reclamation Service.

A chief designer of Pathfinder Dam was George Y. Wisner, consulting engineer for the Reclamation Service.

He noted at a conference in Ogden, Utah, in September 1903, that the Reclamation Service would be required to build masonry dams of great height and emphasized the importance of accurate data to determine stresses to which these structures would be subjected.

Wisner was authorized to hire Edgar T. Wheeler of Los Angeles and together they made careful computations that led to the design of Pathfinder Dam. The magnitude of the job and the remote location of the site introduced many problems in a plan that was intended to assure the utmost in efficiency, safety, and economy of construction and maintenance.

Start of Construction

A contract totaling $626,523 with the Geddis and Seerie Stone Co. of Denver finally was signed and work was started on the foundation excavation in September 1905.

This work too was flooded and it was August 15, 1906, when the first stone was set in the foundation of the dam.

The upper 27 feet of the structure were reinforced horizontally with steel bars placed just back of the stone face and work on the dam—modified many times from the original design—was completed on June 14, 1909.

Construction of the dike, 1,650 feet long with a maximum height of 38 feet, was started March 4, 1910, and was completed May 12, 1911.

The greatest crisis of all, however, occurred during preparation of the site of the dike, designed to close a gap south of the dam.

Shortly after the work got underway, the spring runoff of 1909 became a deluge, rose almost to the top of this low stretch and threatened to change the course of the river—leaving the dam high and dry in the canyon.

The late Alfred James Mokler, a Casper newspaperman-historian, stated in an early written report:

> Men and teams worked night and day for several weeks, piling brush, wood and sacks of sand and dirt in the low place. The flood gates were turned wide open and arrangements were made to blow out a section of the dam with dynamite if the water could not be otherwise prevented from running over this low land.
>
> For 3 or 4 days it was a hard struggle between the men and teams and the gradual rise of the water, and at one time it was thought there was no hope except to blow out a section of the masonry in the dam.
>
> Just at this time, however, seemingly an act of Providence, the water commenced to recede and then all danger was passed.

Explosives Left

The explosives were left in five holes drilled in the downstream face of the dam and the holes were capped with mortar. The dynamite remained in the dam until 1949 when the Bureau decided to install an elevator on the downstream face to replace an old concrete ladderway that led from the south rim of the canyon to valve control stations directly below.

The delicate task of removing the explosives was performed by a Casper oil field torpedo man.

Project Manager Andrew Weiss made no attempt in his excellent *Project Histories* to dramatize his work or the hardships of engineering in the

Pathfinder Dam nearing completion in 1909.

rugged land of the cowboy shortly after the turn of the century.

Weiss accepted all conditions philosophically, if the workmen didn't. Many of the laborers lived in tents in a region of intense winter cold, searing summer heat, blizzards and high winds.

There were few women in the "Equality State" in the early 1900's and perhaps only a dozen or so living near the dam site. More will be said of this later. (Wyoming's population in 1900 totaled 92,500 in a State embracing 97,914 square miles.)

It is believed that the laborers worked a 6-day week, leaving little time for play. Hunting and fishing were excellent and there were occassional Sunday brawls triggered by booze smuggled into camp on the wagon trains.

But there certainly weren't many "nights on the town," since the nearest town of Casper was at least a day's ride for a good horseman—which the laborers probably weren't.

Commented Weiss in his written observations:

> Due to this long distance from the railroad or town, the contractor had considerable difficulty in keeping a full force on the work, especially during 1906 and 1907, when he was paying 35¢ per hour for common labor and skilled labor in proportion. During 1908 and 1909 he paid only 30¢ per hour, and at that rate secured more and better help than could be had during the previous 2 years at the higher rate.

(Industrial warfare accompanied by widespread unemployment in both the gold and coal fields in neighboring Colorado undoubtedly influenced the labor situation at Pathfinder.)

At another point Weiss wrote:

> It was necessary to ship almost all men from Denver (300 miles to the south) and on the average a poor grade of labor was secured. The force was continually changing, many of the men not staying long enough to work out their transportation advanced.

Daily Wages

Average wages per day for experienced workers: masons, $5.63; blacksmiths, $5.56; foremen, $4.17; stone cutters, $4; drivers with teams, $4.64; drill-men, $2.94.

Several Pathfinder women, wives of officials, lived rather comfortably in homes at the construction camp, just downstream from the dam. But there were also a number of wives of workmen who lived in dugouts, tents and makeshift shacks in the gullies nearby.

An interview was conducted for this article with Mrs. Emily Mosher of Casper, who was born November 4, 1906, in a tent a few hundred yards upstream from the dam. A lady of great humor and charm, Mrs. Mosher was the daughter of Charles T. Demarest, who had subcontracted for the haulage of cordwood and sand.

Mrs. Emily Mosher of Casper remembers the greasing of freight wagon wheels at night. She was born at Pathfinder Dam; the photo was taken this year.

Mrs. Mosher, delivered by a full-time doctor employed by the contractor, was told that she was "placed in the oven of our cooking stove for some time to keep me warm."

Mrs. Mosher left with her parents when she was 4 and reconstructs the life at Pathfinder from accounts of her mother and father.

"I do remember that my mother was deathly afraid of snakes at the dam and that I got a great thrill out of watching the men greasing the wheels of the freight wagons when they finally arrived at camp from Casper, usually late in the evenings," Mrs. Mosher said.

Contrary to legend, there were no known fatalities in construction of Pathfinder Dam itself. On February 9, 1912, however, five workmen were knocked off the south rim of the canyon by a loosened cable and plunged 160 feet to their death.

Two of the victims, whose relatives could not be located in the United States, were buried on a barren shelf overlooking the dam. The graves are there today.

These deaths occurred during construction of the concrete ladderway on the canyon wall.

During construction of the dike there were 120 horses on the job at one time, along with 200 men.

Horse and mule teams hauled all materials, equipment and supplies for the camp from Casper. The cost to the Reclamation Service early in 1910 was $1 per hundredweight for general freight and $1.10 for hay and explosives.

Prized Steam Shovel

A prized piece of equipment was added during construction of the dike—a Marion steam shovel, Model 40, 1½-yard dipper. It was dismantled in Casper and erected again at Pathfinder.

The average price of cement delivered at Casper was $2.68 a barrel but the contractor was paid an additional $3 per barrel for haulage.

Two overnight stops usually were made by the freight outfits out of Casper—the first at the Rollin Clark ranch on Bates Creek, about 21 miles upstream, and the second at the old settlement of Alcova, about the same distance beyond. Rollin Clark was the father of Charles D. Clark, who retired recently (1968) as foreman of the Bureau's Alcova Powerplant.

Another problem at Pathfinder was fuel to fire the boilers that produced the steam to run all the stationary machinery. There was no timber on the sage-covered prairies around the dam and it thus became necessary to haul in pinewood from Pedro Mountain, about 12 miles to the south.

From February 1 to June 1, 1910, there was never enough wood on hand to run the plant 48 hours.

A camp then was established on Pedro Mountain and wood again became available at $11 per cord. Coal and crude oil also were tried but they proved too expensive.

Built at a cost of $2,225,000, Pathfinder Dam was but the first of five storage dams and related multipurpose water structures eventually to go on the North Platte Project in its six decades. The Project crop values have grown to $926 million.

\# # #

College students lived with, worked with and taught migrant workers

Arkansas Students Take Challenge in Idaho

by **WILLIAM SANDERSON, Realty Office, Minidoka Project, Idaho**

TWENTY college students from nine Arkansas college campuses came to the Minidoka Project last summer. They learned to communicate and become friends with the Mexican migratory farm workers.

Chaperoned by Mr. and Mrs. Gerald Counds, there were nine boy and 11 girl students. Mr. and Mrs. Counds both speak Spanish fluently and recently returned from a tour of duty with the Peace Corps in South America. Mr. Counds is now Baptist Student Director at Arkansas A&M.

All the students paid their own expenses to Idaho and they worked in the beet fields to support themselves.

This summer challenge was at the labor camp on Hynes farm of the Bureau of Reclamation's Minidoka irrigation project, near Paul in south-central Idaho.

Each day three of the college girls stayed in from work and operated a day-care center, free of charge, for the 30 or 40 Mexican children. Health, music, and some school subjects, including English, were taught in the care center. Sewing classes were also given to both adults and children desiring to learn.

Started Recreation

The students inaugurated an evening recreational program of volleyball, baseball, and soccer, in which they participated with the Mexican people. Three of the group are accomplished guitarists, and singing sessions were held with folk songs and sentimental favorites predominating. A "coffee hour" to which anyone could come and play games, or just visit, was one of the activities.

The group lived in five of the labor camp units which were the same as those for the Mexican people. As in most labor camps in this area, there was nothing pretentious about the facilities. They meet only the necessities.

The three student teachers and the class look happy. Mrs. Counds and her young son are at left.

In the beginning, the students' attempts to be friendly with the Mexican people were not well received. Then the Catholic Priest of Rupert, Idaho, helped "break the ice." He persuaded the migrant workers that the intentions of the students were good.

The students were serious in their objectives of establishing friendship and understanding with the migrant workers and to learn their language. Most of the adults and children now look forward to such associations.

On August 1 the group returned to their respective college campuses where they would again pursue their studies in medicine, social science, liberal arts, and other chosen fields. Perhaps only a small dent has been made in reducing racial barriers which exist, but there will be considerable warm satisfaction for the good intentions of the people involved. # # #

This is the way to reduce the work on rows of beets—each person takes a row at a time.

Weed growth multiplying. Apply herbicides at low concentrations

Stop Waterweeds With Chemicals

by DEAN M. SCHACHTERLE, Natural Resources Specialist, Bureau of Reclamation, Denver, Colorado

WATERWEEDS are on a rampage throughout the West. These plant pests, particularly troublesome in irrigation canals and laterals, are increasing at alarming rates.

Aquatic weeds clog waterways every year, and each year thousands of dollars are spent in control work and chemicals. While increasing use of herbicides offers improved weed control, there are restrictions to introducing the chemicals into water.

The limitations include possible toxic effects on humans and other warm blooded animals. Toxicity could also extend to fish and other aquatic animals and plants. A herbicide's effect on all crops to be irrigated is a consideration, as is its persistence level in water and soil.

Up to the present, most farm crops in Colorado, and the other Western States, are not extremely sensitive to the aquatic herbicides being used in irrigation water. Also, most seasonally operated irrigation canals are not considered important public fisheries.

However, misuses could cause severe restrictions to be placed on the use of chemicals in water, and the only other means of cleaning weeds from ditches is by mechanical apparatus. It is to our benefit to find a satisfactory application of herbicides, or it may become necessary again to use only the more costly and cumbersome mechanical methods of control and removal.

Aquatic plants may be classified into three main categories: submersed, emersed and those that float or attach to surfaces of rocks or concrete structures.

Troublesome Types

Submersed weeds are rooted plants which grow mostly under water. They are troublesome in irrigation canals and drains, in recreational waters and in some potable water reservoirs. Examples of submersed weeds are pondweeds, chara, elodea and watermilfoils.

Emersed aquatic weeds are also rooted but extend most of their foliage and seed heads above the water surface and are quite troublesome along banks and shallow edges. Cattails, Tules, reeds, and other tall watergrasses are examples.

These specialists are making a herbicide test in a model irrigation canal. They are from left, Naman Otto and Thomas Bartley.

All of these weeds restrict or prevent waterflow in canals, laterals or drainage ditches. They also cause excessive deposits of silt to accumulate thus reducing the free flow and capacity of the channel and finally causing water pollution associated with poor drainage of lowlands and partially restricted drainage channels.

Filamentous green algae are threadlike plants without roots, leaves or flowers which float on water or may attach to objects. The floating kind often form dense mats and may plug sprinkler irrigation systems, siphon tubes and irrigation canal water control structures and farm outlets.

Algae are also commonly found growing on water measuring structures such as Parshall flumes, weirs, sparling meters and on the wetted surfaces of concrete lined irrigation canals. Presently antifouling paints fortified with slow releasing toxicants, copper or tributyl tin oxide, are being successfully used to help prevent algae growths on water measuring structures.

Considerable progress has been made in the past few years in discovering and developing effective herbicides for controlling most of the weeds that grow in and on water and on banks adjacent to aquatic sites. There are now some 20 kinds of her-

A plant specialist is shown examining a weed test in an experimental irrigation lateral at the Denver Federal Center.

bicides registered for control of aquatic and bank weeds. Some 11 of the 20 herbicines do not harm fish at concentrations necessary to control weeds.

Users Pay

Control measures for aquatic weeds on irrigation systems are generally paid for by the water users. This payment comes in the form of operation and maintenance charges. The cost varies with the herbicide being used and the concentration being applied.

Herbicides are applied in water on a basis of cubic feet per second of flow. Hence, the more water involved, the higher the costs. All aquatic herbicides are applied at low concentrations to avoid many harmful side effects.

Average costs of the common chemical controls in Colorado are:

Copper sulfate applied for control of filamentous green algae in irrigation canals varies in cost from 10 cents to 35 cents per cubic foot per second of water flow depending upon hardness of the water and the amount of infestation.

Xylene applied in irrigation canals and laterals for control of most pondweeds costs from $5 to $6.25 per cubic foot per second of flow of water.

Dalapon applied to cattails costs about $28 to $30 per acre.

Aquathol applied in small lakes and ponds to control watermilfoil, most rooted pondweeds and green algae cost about $25 per acre-foot of water in the pond or lake at the time of treatment.

Residue Considerations

When choosing a herbicide it is important to consider residues which remain not only in water, soil and fish, but also residues in crops irrigated with treated water, and the toxicity of each herbicide to domestic and wild animals and humans. Caution is recommended. The potential dangers of herbicides in flowing water are much greater than when herbicides are applied to soils.

The threat of aquatic weeds is real. They are increasing because of marked increases in nitrates and phosphates found in most water.

These nutrient buildups are greater where domestic sewage, industrial wastes, runoff from livestock feedlots, fertilized farm fields and other wastes from urban and rural areas are carried into the irrigation system. Increased growth of weeds is going to necessitate increased control measures if the waterweed problem is to be solved.

Because pollution is fertilizing waterweeds, our aquatic program must tie in with our clean water programs. While so far we've only scratched the surface, extensive studies are being made to determine the extent of residues and to help develop less hazardous herbicides and safer application techniques. # # #

CONTROL AGENTS FOR SUBMERSED WEEDS

Years of field testing with acrolein and copper sulfate as control agents for submersed aquatic weeds indicates that both chemicals, used correctly, are effective in suppressing rooted forms of aquatic weeds in irrigation canals.

Use of acrolein over a 5-year period in the Pacific Northwest showed the liquid herbicide to be effective and economical in suppressing five varieties of pondweed, elodea, water buttercup, and filamentous green algae.

Pondweed suppression was excellent along a 15- to 20-mile reach when acrolein was added to the channels at a concentration of 0.10 part per million over a 48-hour period on a 2- to 4-week schedule. Flows ranged from 700 to 2,000 cubic feet per second during the treatment schedule.

Field work conducted by the Bureau of Reclamation and the Agriculture Research Service demonstrated, however, that the effective concentration of 0.10 part per million (p.p.m.) in large canals gives inadequate suppression in streams carrying less than 700 cubic feet per second.

Concentrations of 0.6 to 15 p.p.m. are required in these small streams. The failure of acrolein to suppress horned pondweed was a significant finding in these field applications.

The Bureau's field work with copper sulfate showed it to be effective in controlling leafy pondweed and sago pondweed along a 9-mile reach of unlined channel in an irrigation canal near Loveland, Colo. Dry crystals of copper sulfate were dispensed by a screw-type volumetric feeder with a timing device.

34-Day Delay

Tests in 1966 began in early June, when weeds already had reached lengths up to 10 inches in the canal. Not until 34 days after the start of the application of copper sulfate was the first significant injury observed on leafy pondweed downstream.

In 1967, feeding was started in May on the same day water was first turned into the canal. Pondweed suppression was more effective than during 1966, but the effects of residual copper in ditch bottom soil and cooler water temperatures in early season might be important factors in this observation.

Copper sulfate experiments was planned to continue this summer on the same canal near Loveland, Colo.

A technical paper by W. Dean Boyle of the Boise, Idaho office, and Thomas R. Bartley of the Denver, Colo. office, on the control agent tests was presented last February at the Weed Science Society of America Conference in New Orleans. Also Reclamation has published a report (WC–32) detailing results of the 1966 copper sulfate study, and is preparing a similar report on the 1967 activities.

# # #

Cheering spectators line the ice covered lake as racing snowmobiles fly down homestretch during the first annual Blue Mesa Snowmobile Rally Races held last January. This is on part of Reclamation's Curecanti project and the National Recreation area supervised by the National Park Service. (Also see Blue Mesa article and photos on page 96.)

FEBRUARY PUBLICATION ON POWELL CENTENNIAL

The February 1969 issue of the quarterly *Reclamation Era* will be a special issue devoted to the 1969 Powell Centennial.

Observance plans for the 100th anniversary with the theme: "1869–1969 A Century of Achievement, Our Debt to John Wesley Powell," are moving forward.

The zealous career of this amazingly prescient scientist and organizer led to Powell conducting the irrigation surveys which became the basis of the Bureau of Reclamation, created in 1902. He established the Geological Survey and the Smithsonian Institution's Bureau of Ethnology.

Joining the Interior Department in suitable observances for the Powell Centennial next year are the Smithsonian Institution and the National Geographic Society. Chairman of the Powell Centennial Committee is C. S. Denny of the Geological Survey, U.S. Department of the Interior, Washington, D.C. 20240.

Individuals and organizations interested in Western history are asked by the cooperating agency heads to join in paying homage to the remarkable American, Major Powell.

BENEFITS OF DAM TOLD BY MONTANAN

(*Editor's Note:* This excerpt of a letter about a Reclamation dam was received by Hon. Mike Mansfield, U.S. Senator from Montana.)

For some time, I have wanted to write to you regarding how well the Clark Canyon Dam in Beaverhead County has worked out and of the many benefits it has brought to our economy here and to the State of Montana, as well as to the United States as a whole. This excellent project has paid for itself twice already in benefits that could be definitely determined. Once, when the dam controlled the Beaverhead River in 1964 when the rest of the State was flooding and when the added inflow from the flooding Beaverhead River would have compounded the disaster many times had it not been for the Clark Canyon Dam. Again, in 1966, when our county suffered the worst drought in its history, water from this project filled the needs of all who were under (downstream from) the dam and once again a complete disaster was avoided.

(Signed) Carl M. Davis
Dillon, Mont.

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has carried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form may be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. D	

Enclosed find $______________ (check, money order, or Documents coupons). Please enter subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1 a year; 25 cents a tional for foreign mailing.

Name____

Address____

City, State, and ZIP Code______________________________

Leave Sunken Car Safely

Some men who must drive vehicles on the sides of ditches or on canal roads should be alert to the dangers of the vehicle going into the water. One man reportedly drove a tractor into a canal, the machine rolled over pinning him under it and he drowned.

If a car does go into an irrigation ditch, occupants should stay in it until the car gets to the bottom. This may not sound reasonable, but it was found the best way to solve the most critical problems during tests conducted in Mississippi and Louisiana where cars were purposefully sunk. People in the cars tried to get out when the car was floating, but there was too much pressure against the doors at that time. When the occupant calmly remained inside until the car got to the bottom, the pressure was equalized and they could open the door and float to the surface.

Coat With Fluorescent Paint

A light reflecting fluorescent paint is suggested to coat the inside of underground valve boxes and also the pipe inside the boxes that protects valves and other equipment. This makes it much easier to see a reasonable depth in the usually unpainted box or where the box and pipe have a protective coat of unreflecting or even light-absorbing paint.

By shining a beam of light into the fluorescent painted interior, reflection makes it possible to clearly see the position of valves and other equipment.

Dye for Weed Control Chemical

Most weed control chemicals, particularly those of the soil sterilent type, are colorless. Because rain is needed to activate them, these chemicals do not usually affect the weed foilage immediately after spraying.

It is not uncommon that field operations of an urgent nature may interrupt the weed spraying job and several days lapse making it almost impossible to see where the spraying stopped. To avoid a chance of overlapping the area already sprayed or missing an area entirely, a dye could be mixed in the control chemical to make a clear outline show where spraying ended, even after several days.

Accordingly, no solution is wasted or motion lost, and the possibility of overactivating an area with control chemical is eliminated. Although some people have used this idea, many have not known of it.

The "pig" shown part way out of the pipe, and the motor winch at left, which does the pulling, is the equipment needed for this type of pipeline inspection.

Pig Inspects Pipe

One kind of pig is for pork. But there is also a "pig" not so well known; it is for locating blockage in newly laid, closed-drain systems.

The usual method of inspecting a new drain pipe for possible obstructions, which would prevent flow of the desired amount of water, is to float a ball through it. This method is satisfactory providing there is sufficient water flowing through with the ball, and the pipe is clear. If the ball gets caught somewhere in the line, it occasionally becomes expensive for the constructing organization to excavate and break into the line on a "trial and error" basis in an attempt to locate the obstruction.

Preparing for a more efficient method is threading a light-weight aeroplane control cable through each section of pipe as it is laid in place. This cable should be of sufficient length to reach through the pipeline, from manhole to manhole, or from manhole to the end of the drain. The cable is reeled off a small spool carrier winch.

When the pipeline is ready for testing, the "pig"—a metal frame designed like a short, large-diameter pencil sharpened on both ends—is fastened to the end of the cable. Another cable, a trailing line, is fastened to the back end of the "pig" and the device is started on its way through the pipe by pulling on the first cable.

When being pulled the "pig" might remind one of the movement of a real pig or perhaps a slow torpedo.

If an obstruction is encountered along the line, the pulling halts. The trailing cable is then marked at the pipe entrance, and the "pig" is pulled out of the pipeline backwards.

The distance to the obstruction can be transferred from the marked cable to the surface of the ground, and repair work can get underway with no loss of accuracy.

U.S. GOVERNMENT PRINTING OFFICE : 1968 O - 318-428

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
S-6607	Columbia Basin, Wash.	July 3	3 hydraulic turbines for Grand Coulee 3d powerplant.	Guy F. Atkinson Co., d.b.a. Willamette Iron & Steel Co., Portland, Oreg.	$19,537,543
S-6608	do	Aug. 23	Furnishing and installing 3 615,385-kv.-a. generators for Grand Coulee 3d powerplant.	Westinghouse Electric Corp., Denver, Colo.	22,044,000
C-6635	do	July 29	Initial excavation for powerplant, including construction of a cofferdam and access road, Grand Coulee 3d powerplant.	Gordon H. Ball, Inc., Danville, Calif.	12,503,593
S-6638	do	July 30	2 pump-turbines for Grand Coulee pumping plant, units P7 and P8.	Nydqvist & Holm Aktiebolag, Trollhattan, Sweden.	730,000
C-6644	Missouri River Basin, N. Dak.	July 1	Construction of Snake Creek pumping plant No. 1.	White Bros. Construction Co., Inc., and L. D. Shilling Co., Inc. Walla Walla, Wash.	7,403,627
C-6645	Central Valley, Calif.	Aug. 2	Construction of 32.7 miles of pipelines for Westlands Water District distribution system laterals 19, 21, 23, 25, and 26.	W. M. Lyles Co., Fresno, Calif.	3,223,526
C-6650	Missouri River Basin, Wyo.	July 15	Construction of Glendale substation, stage 01, and 69-kv. South Cody tapline.	Raymond P. Mayeaux, d.b.a. Capitol Electric & Engineering Co., Denver, Colo.	193,246
C-6651	Southern Nevada Water, Nev.	July 9	Construction of intake tunnel, underground construction and opencut excavation for pumping pumping plant No. 1.	S. S. Mullen, Inc., Seattle, Wash.	2,813,060
C-6654	Missouri River Basin, Nebr.	July 24	Modifications of upstream slope for Merritt Dam.	Abel Construction Co., Lincoln, Nebr.	109,134
C-6655	do	July 17	Construction of stage 02 additions to Stegall substation.	Raymond P. Mayeaux, d.b.a. Capitol Electric & Engineering Co., Denver, Colo.	310,667
S-6656	Minidoka Area, Idaho	July 5	Furnishing and installing 1 new armature winding for generator unit 1 at Palisades powerplant.	Westinghouse Electric Corp., Denver, Colo.	159,978
S-6659	Missouri River Basin, South Dakota-Nebraska.	July 26	15 shunt reactors for Fort Thompson, stage 05, and Grand Island, stage 01, substations.	General Electric Co., Denver, Colo.	143,880
C-6664	Parker-Davis, Calif.	Aug. 27	Construction of 64 miles of Parker-Blythe 161-kv. transmission line No. 2.	Interstate Electric Co., Inc., Salt Lake City, Utah.	1,467,072
C-6667	Missouri River Basin, Iowa.	Sept. 19	Construction of stage 04 and 05 additions to Creston substation.	Electrical Builders, Inc., Valley City, N. Dak.	459,165
C-6670	Missouri River Basin, Nebr.	Sept. 5	Milburn diversion dam dike protection	Bushman Construction Co., St. Joseph, Mo.	105,815
C-6674	Central Valley, Calif.	Sept. 18	Construction of Interstate Highway No. 5 lateral crossings for Westlands Water District distribution system.	Charles Eugene McLaughlin, d.b.a. Gene McLaughlin Construction Co., Fresno, Calif.	252,394
C-6679	Canadian River, Tex.	Sept. 27	Modification of main aqueduct structures, stations 2975+90 to 8090+00.	Brown-McKee, Inc., Lubbock, Tex.	110,841
00C-1012	Columbia Basin, Wash.	Sept. 11	Construction of 30.5 miles of buried pipe drains, block 46.	John M. Keltch, Inc., Pasco, Wash.	486,268
00C-392	Colorado River Storage, Utah.	Sept. 26	Furnishing and erecting protective fencing, rock bolts, railing and ladders for Flaming Gorge Dam.	E. V. Chettle, Salt Lake City, Utah.	104,121
02C-52	Missouri River Basin, S. Dak.	Aug. 8	Erecting steel towers, stringing conductors and ground wires for Fort Thompson-Fort Randall and erecting steel towers for Utica Junction-Sioux Falls and Oahe-Mobridge 230-Kv. transmission lines.	Lindberg Construction Co., Jamestown, N. Dak.	112,950
04C-73	Missouri River Basin, Mont.	Sept. 19	Furnishing and applying 2.8 miles of buried asphaltic membrane lining for East Bench canal, station 411+00 511+47 and station 2350+75 to 2410+67.5.	N. L. Garrick Construction Co., Missoula, Mont.	160,928

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

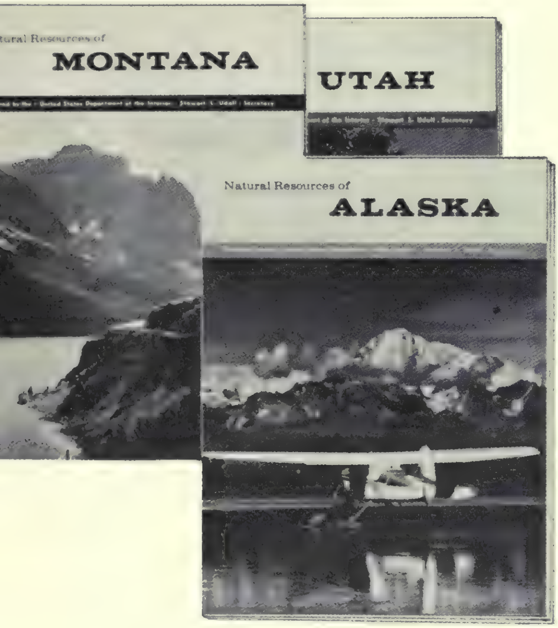
U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.



THE NATURAL RESOURCES OF OUR STATES

Available States listed on mail order coupon below.

MAIL ORDER FORM To:
Superintendent of Documents,
Government Printing Office, Washington, D. C. 20402

Enclosed find $..................... (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

— Alaska. I 1.91:Al 1s	65¢	— Montana. I 1.91:M 76
— Texas. I 1.91:T 31	45¢	— West Virginia. I 1.91:W 52 V
— Arizona. I 1.91:Ar 41	45¢	— Ohio. I 1.91:Oh 3
— Massachusetts. I 1.91:M 38	45¢	— Washington. I 1.91:W 27
— Colorado. I 1.91:C 71	50¢	— New Mexico. I 1.91:N 42 M
— Oregon. I 1.91:Or 3	50¢	— Idaho. I 1.91:Id 1
— Nevada. I 1.91:N 41	45¢	— Utah. I 1.91:Ut 1
— California. I 1.91:C 12	60¢	— South Dakota. I 1.91:So 8 D
— Indiana. I 1.91:In 2	45¢	— Wyoming. I 1.91: W 99

Name ....

Street address ....

City, State, and ZIP Code ....

FOR USE OF SUPT. D

← TO INSURE ACCURATE DELIVERY, PLEASE COMPLETE MAILING LABEL

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

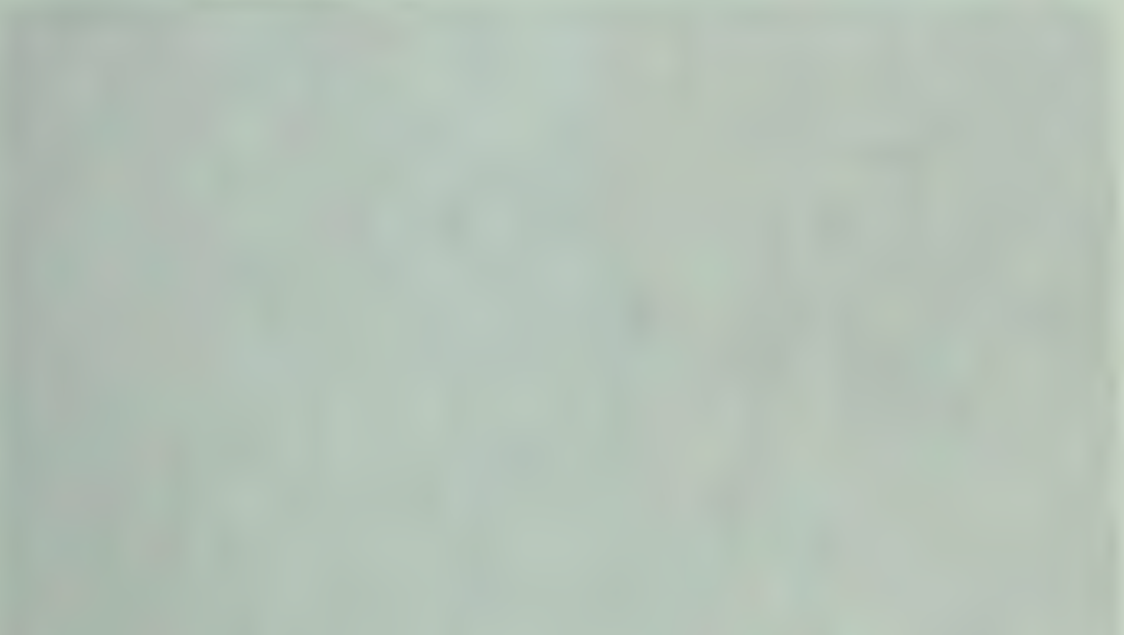
POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

Name ....

Street address ....

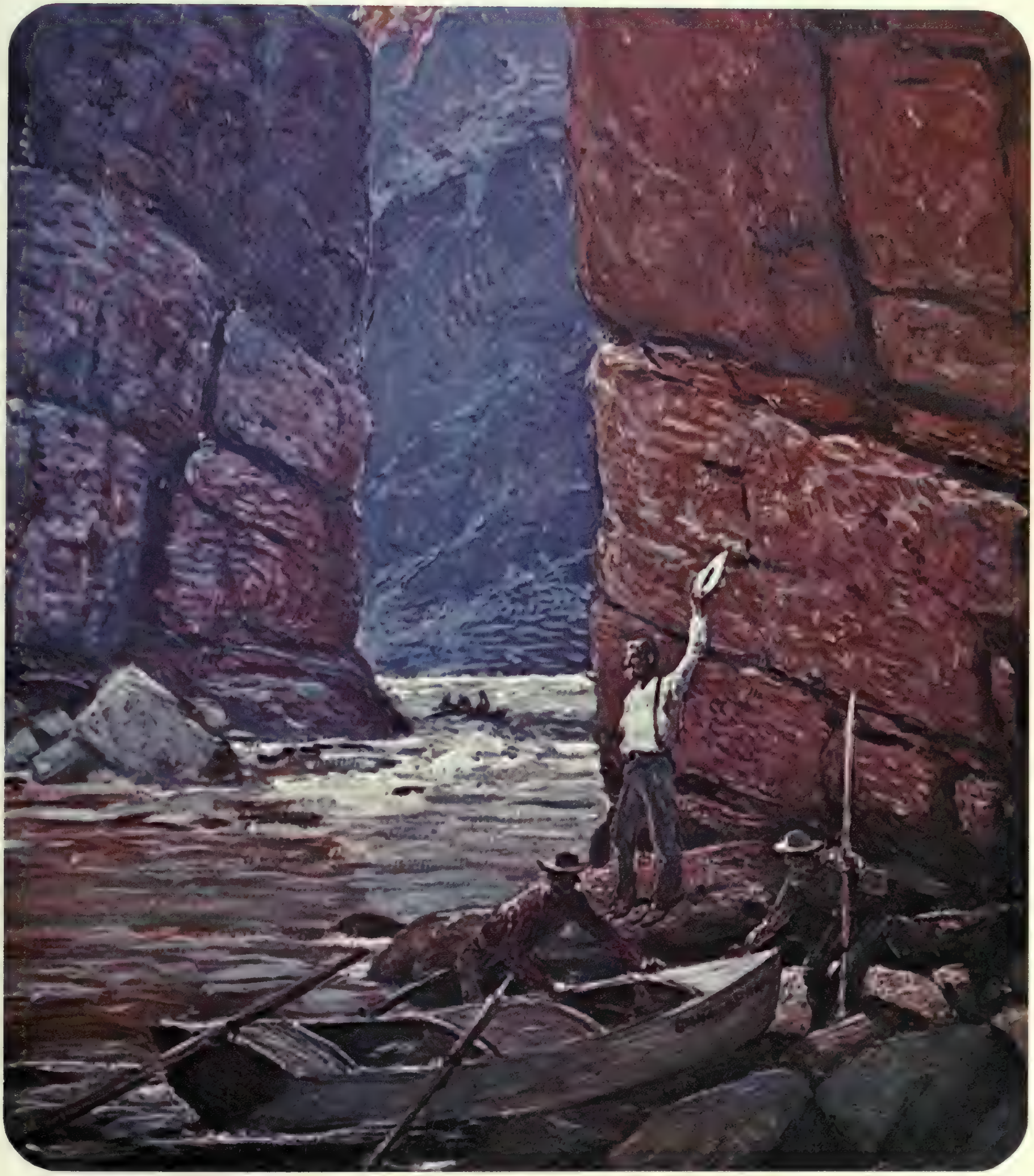
RECLAMATION

era



RECLAMATION era

A WATER REVIEW QUARTERLY



CENTENNIAL ISSUE: 1869-1969
Colorado River Explorer Powell

February 1969 Vol. 55, No. 1

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Floyd E. Dominy
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

Appraisals Note Powell Gains

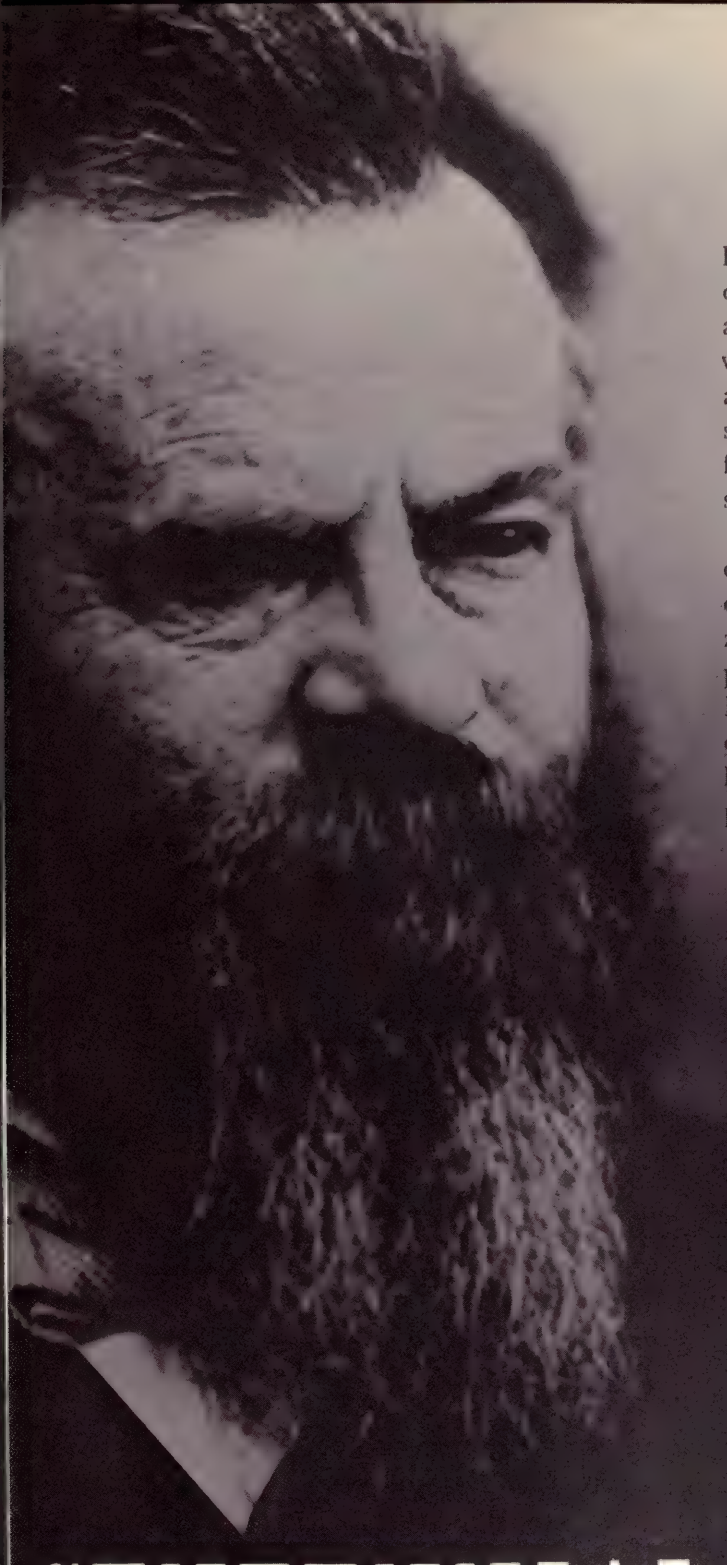
"Goes to Washington as a Scientist"

"Major Powell went to Washington as a scientist, not a politician, and began one of the greatest campaigns in politics—to force upon an unwilling government measures to reclaim the arid West and preserve the natural wealth of the country against the ruthless exploitation and monopoly control by vested interests. The conservation movement, the development of a federal land policy, the elevation of science in government bureaus to a position of dignity, were in large part inspired and directed by Major Powell."—William Culp Darrah ("Powell of the Colorado," Princeton University Press, 1951).

"Personification of Ideal of Service"

"Powell, the personification of ideal of public service that seems peculiarly a product of American experience. As the source and mouthpiece of ideas three quarters of a century ahead of their possible fulfillment, yet rooted in that same American experience. As the father of government bureaus far-reaching in their own effects and influential in the models they provided for other and later government agencies. Above all, as a champion and an instrument of social understanding and social change. . . Major Powell repudiated that reading of Darwinism which made man the pawn of evolutionary forces. In his view, man escaped the prison in which all other life was held, because he could apply intelligence and will to his environment and bend it."—Wallace Stegner ("Beyond the 100th Meridian," Houghton-Mifflin, 1954). (Also see Frank E. Smith's appraisal on page 17.)

The cover presents a color painting of the John Wesley Powell Expedition in action on the famous voyage a hundred years ago. As it might well have happened, the man standing represents Explorer Powell himself. He is exuberantly waving his hat and probably shouting echoing cheers to the crew of the third unpictured boat in his group, or simply at the mystically beautiful canyon along the course of the challenging river; his sturdy companions meanwhile skillfully handling their boating tasks. Artist Nick Eggenhofer did the painting, and our use of it is by courtesy of the Western History Department, Denver Public Library, Colo.



CENTENNIAL TO HONOR J. W. Powell

The 1969 Centennial honoring John Wesley Powell will emphasize this explorer's conquest of the Colorado canyons. Powell bolted a chair to the deck of his craft for the second voyage, as shown in the photograph on page 3, and the picture has long been the renouned symbol of both of the hazardous, but successful efforts. The first was the 1869 trip and the second in 1871–1872.

This year's celebration also will focus on the career of the amazingly prescient scientist and organizer. His broad abilities and exploring zeal led to the establishment or expansion of pertinent Government programs, including the Bureau of Reclamation. Powell's practical concepts serve today, in some respects as guides for highly recognized programs of usefulness for people and their environment.

Blocking Travel

Powell was one of the Nation's outstanding examples of scientist-explorers. He launched his two noted journeys from Green River, Wyo. to explore the deeply cut Green and Colorado Rivers, which always were obstacles blocking central travel routes to the West Coast. Immigrants coming from the East either perilously crossed the canyons, tried to cross, or chafed at the delay of detouring scores of wagon-miles around this forbidden region.

Powell was a geologist, ethnologist, and geographer. Also, because he was the first outstanding leader in reclamation, he might fairly be called the fosterfather of reclamation. His assesments of Western resources, and his warnings of land and water-use problems which were sure to develop—largely ignored or opposed in his day—are today reflected in our most advanced programs of dynamic reclamation and conservation.

It is fitting that now, burdened as the Nation is with the need to make conservation decisions which will affect posterity, we take the time to recall the continuing contributions of this American who became an heroic figure. Considerable assistance in our understanding him as a person is provided by early photographs exhumed for use in this issue of *Reclamation Era*.

The Photos

Several of the illustrations on these pages had been stored away with only scant explanation of details, but their variety—especially those showing Powell in costumes—denote that he was greatly interested in people and their way of life. His ethnic knowledge and understanding of Indians and their language were some of his highly valued capabilities.

For example, in one photograph he is conferring with a group of Indians, and is seen sitting beside Jacob Hamblin, a famous Indian agent, peacemaker, pioneer and Mormon missionary. Powell spent much time traveling with Hamblin in Utah, Arizona and possibly Nevada. Most of such older photographs were made available from the National Archives, the Library of Congress and the Smithsonian Institution in Washington, D. C.

Powell enjoyed posing in costumes, as seen below, but we found no photos of him smiling. At the scene of action, right, is his chair-boat, "The Emma Dean." The Powell monument with steps is at Grand Canyon, and the taller one is at Arlington Cemetery. At lower center is the Powell group with boats at Green River launching point. At top right, Powell attends 2 Paiute tribal conferences, seated, he is beside well-known Indian agent Hamblin. Lower right, Powell, in right foreground at Survey staff lunch, about 1890.







First 35 Years

Powell was born March 24, 1834, at Mount Morris, New York. The qualities which enabled him so splendidly to perform his many self-imposed tasks, according to one of his companions on the river trip, were an inheritance from his parents, who possessed more than ordinary intelligence. His father's name was Joseph, his mother's Mary Dean. John Wesley was the fourth of nine children.

The family moved to Ohio in 1838, and to South Grove, Wisconsin when "Wes" was 12. The precocious youngster attended such country schools as was provided, but he was largely self-taught.

For brief periods, young Powell attended Illinois Institute, Illinois College, and Oberlin College. He took an early interest in natural science investigations. Before reaching age 27 he had taught school in Wisconsin and Illinois, taken lecture tours, and made long collecting expeditions, including along the Mississippi River.

Convinced that war with the South was inevitable, the winter of 1860 and 1861 found this resourceful man studying military tactics and engineering. He enlisted in the 20th Illinois Volunteer Infantry May 8, 1861. Although the next year he was wounded in the bloody Battle of Shiloh and his arm was amputated, he continued to serve with characteristic strength and fortitude until 1865 when he was discharged with the rank of Major and brevet Lieutenant Colonel.

That same year he returned to the college classroom as professor of geology. But he was still a man of action, and in 1867 and 1868 he led expeditions to the Rocky Mountains. In that arid and semi-arid frontierland he not only collected geological specimens and artifacts, but he also studied and became acquainted with the region's pioneering settlers and Indians.

Other significant events of Powell's life, starting with his celebrated 1869 voyage, are presented on page 23.

Centennial Highlights

Various phases of the John Wesley Powell story will be presented in publications during the National Centennial.

Articles and illustrations on these pages of *Reclamation Era* were especially prepared as a Centennial feature. The Bureau of Reclamation has joined with other agencies and private groups in sponsoring or providing information for a number of Centennial projects.

The Smithsonian Institution and the National Geographic Society also are joining in the observance, the theme being "A Century of Achievement, Our Debt to John Wesley Powell."

Powell's 1869 expedition is planned for reenactment this year. People interested in the history and development of the western United States also will find interest in Powell exhibits which will be on display this spring and summer in various parts of the country.

Publications and Articles

The Geological Survey is preparing publications and a motion picture for the Centennial. That agency, which Powell directed from 1881 to 1894, will distribute a collection of articles under two covers dealing with Powell and his work: "The Grand Canyon Region and John Wesley Powell," and "Powell and the Indians of the Colorado."

The nine-decade-old Survey also will publish an album of some of the best of Beaman-Hiller's photographs of Powell's second Colorado River trip, as well as a popular account of the geology of the Uinta Mountains.

The Survey motion picture will show and describe the geology of the Grand Canyon as Powell viewed and interpreted it.

Other publications planning content on the Powell celebration include: National Geographic magazine, of which Powell was a cofounder; Arizona Highways magazine; the May issue of GeoTimes, published by the American Geological Institute; and a publication by the Sierra Club. Oil companies and the Utah Highway Department plan to print a red line "Powell Scenic Route", or related notations on their highway maps.

River-Runs and Exhibits

An anniversary ceremony of the start of the Powell expedition is planned for May 24 at Green River, Wyo. The day's activities will include formal designation of "Expedition

Island" as a National Historic Site by the National Park Service. The complete Powell voyage will be re-enacted by about 6 boat crews to be launched at intervals during that day for a 90-day trip. The river-runs are sponsored by the Sierra Club.

River float trips will depart from Flaming Gorge Dam after the Green River ceremony. These segmented trips will be conducted by Gaylord Staveley, 3225 North Childress Street, Flagstaff, Ariz. 86001. A display of photographs and woodcuts on the life of Powell is being prepared for the tourist season at Flaming Gorge Dam by the Bureau of Reclamation and the Forest Service.

Vistors to Dinosaur National Monument will be able to see an exhibit there, and in Salt Lake City a Powell exhibit will be in the basement exhibit room of the State Capitol building. The latter is one of the special functions under sponsorship of the Utah State Historical Society and associates.

A re-dedication of Lake Powell will be conducted at Page, Ariz. June 19. Among the groups planning to attend this ceremony is a summer school class from the University of Utah. The Page ceremonies also will commemorate the Centennials of both the Powell trip and the completion of the Transcontinental railroad in Utah. The Page-Lake Powell Chamber of Commerce is sponsoring a Powell museum in Page.

In Grand Canyon, where a sizeable monument and engraved plaque have been erected at Powell Point on the south rim, an observance of the Powell party's encampment will be held in early August. Also planned at this site is a Powell family reunion, and observance of the 50th Anniversary of Grand Canyon National Park.

In the Washington, D.C. area there are a number of Powell memorials: A 12—foot high grave monument is at Arlington National Cemetery. The house where he lived in Washington, D.C. is still standing. A sculptured Powell bust is in the Geological Survey library, and a large Powell expedition oil painting is in the museum of the Department of the Interior Building. Smithsonian Institution is preparing an exhibit of their Powell collection of Indian artifacts.

Publications which Major Powell authored, some of which have been used in preparation of articles herein, will be prominently displayed in libraries throughout the country. A few examples of these are: *Exploration of the Colorado River of the West and its Tributaries* (1875), *Canyons of the Colorado* (1895), *First Through the Grand Canyon* (1928), and his best known work on western resources development, *Report on the Lands of the Arid Regions of the United States* (1879).

This plaque at Grand Canyon is in monument on page 3.

Famous Trip Boost

by MARY C. RABBITT, U.S. Geological Survey

On May 24, 1869, at 1:30 in the afternoon, they started from Green River City, Wyo.—10 men in four small boats. Packed in the boats were 10 months' rations, guns, ammunition, and traps to augment the food supply; ample clothing; tools to build cabins and repair the boats; and a variety of scientific instruments.

Ahead of them lay a region virtually unknown, a blank space on the map.

The Green River at launching point was more than 6,000 feet above sea level, and its rugged course was known for only about 200 miles. They knew the Grand River flowed southwest from its origin high in the Rocky Mountains of Colorado. Somewhere the two rivers would join to form the Colorado River which was best known only in its faraway low reaches a few hundred feet above sea level.

In between was a vast land of mystery, a labyrinth of gorges, high cliffs, and deserts. At only a few places had these barriers been crossed.

There were fantastic stories about the river—those who had tried to explore it disappeared. The Indians were fearful of it.

Three months and six days after the May 24 launching, only five men in two boats emerged from the canyon at "Rio Virgen"—a descent of over 5,000 feet elevation. The men were elated. But they were now gaunt, hungry, their clothing in tatters, their rations reduced to a little unpalatable bread and coffee. They had dared the river and the five men had won.

The last unknown part of the United States had been penetrated.

Powell Returned a Hero

The leader of this expedition was John Wesley Powell, returning to civilization a hero, newspapers throughout the country excitedly carried

owell's Career

MAJ. JOHN WESLEY POWELL in December, 1869, on his return to Wheaton, Illinois, after his exploration of the Colorado River. (Courtesy, William Culph Darrah)

stories of the trip, and he was eagerly sought after on the lecture circuit.

Hitherto Major Powell had been a school teacher, a Civil War artillery officer who had lost his right arm at the Battle of Shiloh, and a professor of natural history at a small Illinois college. The expedition down the Colorado was largely self-financed, though some help had been received from Illinois Normal, Illinois Industrial Institute, the Chicago Academy of Sciences and from the railroads which contributed free transportation.

The trip was purported to be a scientific expedition—its object to "make collections in geology, natural history, antiquities and ethnology" and to "add a mite to the great sum of human knowledge." Yet outside its chief, Major Powell, the crew consisted entirely of amateurs who were serving without pay. Powell said the crew felt remunerated by the opportunity to study. But to the hunters, guides, Indian fighters and sportsmen who made up the partnership, the study could have meant *seeing what no white man had seen before!*

The 1869 trip was often recounted simply as an adventure story, without scientific results, and in terms of the stated objectives the results were indeed scanty. Notes were lost, collections were not brought out, the latter part of the trip so arduous and hurried that observations were not made.

The map of the river was based on memory perhaps as much as measurement. Nonetheless, observations on many aspects of the region were registered in Powell's mind, to be developed, correlated with other observations, and a cause determined. So, it can truly be said that many of Powell's later contributions to science, to science in government, and to the development of the West had their beginning in this first canyon exploration.

Labor for Science

G. K. Gilbert, a noted geologist, described this process at the Powell memorial meeting of the Washington Academy of Sciences, when he said: "Those who labor for science do three things: They observe the facts of Nature, taking pains to observe them accurately; they arrange the observed facts in groups, or classify them; and they discover their relations of cause and effect, or explain them. . .The motive which actuates men of science in all this work is the increase of knowledge, but the results of their labor go far beyond increase of knowledge, for they include also increase of welfare."

Major Powell's observations of the famous voyage are recorded in his letters and diary covering the period from July 2 to August 28, in geologic notes, in newspaper accounts of his return and of lectures given during the following months, and in a report written soon after his return for W. A. Bell's book: "New Tracks in North America."

Unfortunately the diary for the first part of the trip was ill-fated, for when the 3 crew members, the Howlands and Dunn, left the river on

August 28, thinking they had a better chance of survival by going overland, only to be killed by Indians—they apparently took all copies with them.

The "Exploration of the Colorado River of the West" published in 1875 is even today exciting to read, but it contains observations of both the first and later trips without distinction. The Major's observations, however, are supplemented by existing letters and diaries of other members of the party.

Powell considered himself primarily a geologist in 1869, and his geologic observations are naturally most frequent. He gives many descriptions of the rocks, and here and there mentions fossils.

Contributions to Geology

Most interesting, however, are references to the rivers and land sculpture, for Powell's greatest personal contributions to geology—so novel and important in their time—have been in a classification and explanation of the behavior of streams and the processes of erosion.

As he later explained, some rivers cut straight into mountain ranges rather than go around them. Water does not flow uphill, so it must be concluded that the rivers are older than the mountains, and cut through the mountains as they slowly rose across the river's path, much as a log is cut when it is held against a revolving saw.

From these ideas he developed a classification of streams and stream valleys, some inkling of which must have been in his mind even in 1869. Because as early as June 2, while they were in camp at Flaming Gorge, he described to the *Chicago Tribune* how the mountains were carved by the waters and that a canyon is a river channel cut through the range. Later, as they approached the junction of the Green and the Grand, he referred to the river in terms of cutting through an anticlinal axis.

The second fundamental concept credited to Powell is that of the "base level of erosion," which he sensed in 1869 when he told an audience at Salt Lake City that the low lying areas of the Mississippi valley were examples of the

Powell gets earnest attention of this Paiute Indian while conversing about water supply location. Arizona 1873.

greatest erosion, and the Colorado, on the other hand, an example of the least possible erosion.

Powell's contributions to geology, of course, were not limited to his personal achievements. He gave freely of his ideas to the specialists who worked with him as both G. K. Gilbert and C. E. Dutton recalled.

Geology Indebted

But geology is also indebted to him for his service in the organization and administration of science. Geology in the late ninteenth century was in a period of rapid growth, maturing and becoming fully professional. In 1869 when Powell made his first trip down the river, there were already three surveys under government auspices in the western territories. The Powell survey would become the fourth.

Eventually, the interests of the different surveys began to conflict. A Congressional investigation in 1874 did not bring about a change, but in 1878 Congress called on the National Academy of Sciences for advice.

The plan which the Academy submitted was very close to that proposed by Major Powell and led directly to the establishment of the United States Geological Survey on March 3, 1879. Powell was not the first director of the Survey—it was left to Clarence King to organize the new bureau—but he became director in 1881.

Then for thirteen years, Powell guided the Survey as it became national in scope, and its program extended to include topography and water resources investigations.

Attention to Indians

The Major gave considerable attention to Indians, an interest that went back to his childhood. He had been encouraged by Joseph Henry, Secretary of the Smithsonian Institution, to make observations and collections during his trips to the Rocky Mountains in 1867 and 1868. During the winter of 1868-69 he camped close to a tribe of Utes and had made friends with them, studying their language and way of life.

This interest is noted several times in his diary, beginning with the first entry on July 2 about the trip to the Uinta Agency. Also on July 3 he made a visit to observe the Indians' fields. The Major noted that irrigation of the fields had been done by white men, and some sowing as well, but that the Indians were learning fast.

(At this time, most of the Indians had gone to see the railroad which the white men had recently completed at Promontory Point, Utah. This also is a Centennial celebration this year.)

On July 29, just below the junction with the Dirty Devil, he examined the ruins of a house or houses and fragments of pottery. Several times during August he made references to old Indian camps or the remains of old Indian villages.

On September 13, in his lecture at Salt Lake City, one of the interesting discoveries reported by Major Powell was that part of the country had been thickly inhabited by a tribe of the diminutive Moqui (now called Hopi) Indians driven by stronger tribes to the region of the Colorado.

On later explorations in the region, the Major devoted considerable time to learning about Indians. He gained information on their handcrafts and language, their way of living, mythology and beliefs.

So widely did his ability to get along with the Indians become known that in the fall of 1872 he was called on by the Indian agent to address a great council, in their own language, on the advantages of adopting a more settled way of life.

Commissioner to Indians

The following year, he was appointed a Special Commissioner to visit the Indians of Utah and eastern Nevada as part of a program to relocate them on reservations. The report of this trip includes a plea for greater justice for the Indians and for educating them, an idea which was otherwise ignored at the time.

Ethnology had become a serious preoccupation and life-long interest, superseding even geology at times. When consolidation of the surveys was under consideration in 1878, he pleaded for support of ethnologic research by the government. The rapid spread of civilization had placed the white man and the Indian in direct conflict, and while many of the difficulties were unavoidable, many were unnecessary and caused by a lack of knowledge of the Indians.

The Academy made no recommendations about government research in ethnology, but the bill which contained the legislation discontinuing the western surveys and establishing the United States Geological Survey also contained an appropriation for publication of Major Powell's ethnologic researches.

On this basis, the Bureau of American Ethnology was established in the Smithsonian Institution and Major Powell became its first director, continuing to serve in that office until his death in 1902.

Major Powell is best known for his "Report on the Lands of the Arid Region of the United States." This report had been transmitted to the Commissioner of General Land Office on April 1, 1878, and published later that same year. Bernard DeVoto, author, called it one of the most remarkable books ever written by an American, "a book which of itself opened a new era in western and national thinking."

It was more than a report, it was a program, including even proposed legislation. Land west of the 100th meridian, about 40 percent of the country, was arid except in a few areas. Annual rainfall was not enough to sustain an economy based on the traditional patterns of the humid regions. Within this arid region, only a small portion of the country was irriga-

ble, and cooperative labor or capital was necessary for the development of irrigation.

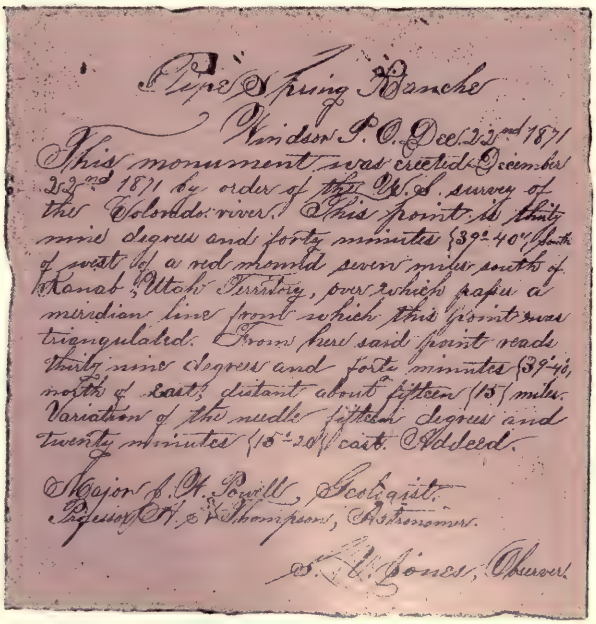
The report pointed out that reservoir sites should be selected and reserved so there would be no problem later in increasing irrigation by storage of water. Timber lands, constituting 20 to 25 percent of the arid region, could not be used as farm lands; they were valuable for forests only and must be protected from fire.

Also In Report

Pasturage lands were of value only in large quantities, and the farm unit there should not be less than 2,560 acres. Pasturage farms, or ranches, needed small tracts of irrigable land and water fronts, so the plots should be shaped by the terrain, and residences should be grouped to secure the benefits of local social organizations.

The ideas he presented in this report had been developed over a period of several years. In the Congressional hearings of 1874 Powell talked of the arid region, questioned how much of it could be used for agriculture, and pointed out the need for revision of surveying procedures.

During the intervening years he hammered away at the same theme, meanwhile accumulating more evidence. But even back in 1869



Pipe Spring Ranche
Windsor P.O. Dec. 22nd 1871
This monument was erected December 22nd 1871 by order of the U.S. survey of the Colorado river. This point is thirty nine degrees and forty minutes (39°40') South of west of a red mound seven miles south of Kanab, Utah Territory, over which passes a meridian line from which this point was triangulated. From here said point reads thirty nine degrees and forty minutes (39°40') north of East, distant about fifteen (15) miles. Variation of the needle fifteen degrees and twenty minutes (15°20') east. Added.
Major J. W. Powell, Geologist.
Professor A. H. Thompson, Astronomer.
S. V. Jones, Observer.

Agreed the penmanship is an artful example of a bygone "Handwriter's Age," this 1871 note mentioning Powell and noted Prof. Thompson was found in the 1930's in a surveyor's rock monument in southern Utah.

he had been observing the nature of the country and the uses to which it could be put.

In his own diary there is the passage already mentioned in which he observed the use of irrigation at the Uinta Agency.

George Bradley's diary (one of his crewmen) records at several places the possibility of irrigation or the suitability of the land for cattle raising, showing that Major Powell's purpose even then was to study the land and how to make use of it.

However, the arid lands report was coldly received in 1878—any proposal to change the disposition of the public domain was unwelcome. (In 1879, during the debates on consolidation of the varied western surveys, the legislation was made acceptable only by deleting a provision for changing the method of surveying public lands.)

A decade later, when the droughts of the 1880's brought about an economic problem, Congress did take action. The Geological Survey was asked to survey and segragate the irrigable lands and reservoir and canal sites in the arid region.

Powell optomistically estimated that it would take several years and several million dollars to get the necessary facts. But time was against him. It soon was realized that all public lands had been closed to entry by legislation, and the survey was discontinued.

Ultimately, of course, Powell's ideas on the use of arid lands and water were vindicated. The Reclamation Service, now called the Bureau of Reclamation, was established in 1902 just a few months before Powell's death.

His life's quest "to add a mite to human knowledge" is being fulfilled in the government bureaus he influenced, in the development of the western region, in the pattern of science in government. His work has proven essential in filling blank spaces on the map of the West, and is bringing prosperity to the many people who choose to live there.

ABOUT THE AUTHOR. Mrs. Mary C. Rabbitt is Assistant to the Director of the Geological Survey, and Survey historian. She has been Editor of Geophysical Abstracts, Assistant Chief of Geophysics, and Staff Geologist for Publications.

Powell's Hard Look at Water Facts

by W. L. (Bud) RUSHO, Region 4 Information Officer

n arid southern Utah, he provided information to a Paiute.

From the time of the cliff-dwellers to the present day, men who have chosen to live in the Colorado Basin either irrigated land to provide food for themselves or they had to move on.

Water from the Colorado River was practically unused in 1869, but the need was great. The new attitude that it was important to put this river to good use, if possible, was held by explorer John Wesley Powell when he headed the first successful explorations of the canyon sections of the river.

Others who have made important studies of the river are C. H. Birdseye, A. P. Davis, F. E. Weymouth, Walker R. Young, and E. C. La Rue. But none are more colorful than the one-armed Civil War veteran, Major Powell, who sat in a chair bolted to the deck of a boat as he ran the rapids of the river.

Powell not only lived through the two death defying experiences on the river, but strongly preached water conservation. His concepts proved basic to influencing the making of the Reclamation law which is still in effect today for the development of beneficial large-scale water resources.

Frederick Dellenbaugh, a member of Powell's 1871 river trip, wrote: "I don't remember whether or not the Major ever had any vision of reclamation during our canyon voyage, but he did very soon after and his Lands of the Arid Region was the result. He then took up the problems of reservoir sites and secured the establishment of a survey for the purpose of surveying and reserving such sites." Cont. on page 14.

THIS COLORADO RIVER STORAGE DEVELOPMENT MAP SHOWS

POWELL'S DREAM-RESULTS OF RECLAMATION

It would be a "dream come true" for Major Powell to see the West's multipurpose water developments, particularly in this land area which he explored 100 years ago. Contributions of the mapped Bureau of Reclamation projects include vital water service to many industries, 11.6 million people, and 2.3 million acres of land. The "Powell's Dream Come True" article is on page 18.

50 0 50 100 150 MILES

EXPLANATION

Irrigated and Irrigable lands

Reclamation dams

Reservoirs

Colorado River basin boundary


COLORADO
ARIZONA
NEW MEXICO
CALIFORNIA
BAJA
OCEAN
Santa Fe
Albuquerque
El Paso
Flagstaff
Cedar City
Las Vegas
Tucson
Buckhorn
Mexicali
San Diego
LAKE POWELL
GLEN CANYON
LAKE MEAD
HOOVER
LAKE MOHAVE
DAVIS
HAVASU LAKE
PARKER
HEADGATE ROCK (BIA)
ALAMO
PALO VERDE DIVERSION
SENATOR WASH
IMPERIAL
LAGUNA
GILA
PAINTED ROCK
HORSESHOE
LAKE PLEASANT
BARTLETT
CAVE CREEK
STEWART MOUNTAIN
ROOSEVELT LAKE
ROOSEVELT
APACHE LAKE
HORSE MESA
MORMON FLAT
TRILBY WASH DETENTION
SALT RIVER
WHITLOW RANCH
SAN CARLOS LAKE
COOLIDGE (BIA)
SAN CARLOS (BIA)
MANNY FARMS (BIA)
GANADO (BIA)
NAVAJO
PINE RIVER (BIA)
HAMMOND PRO.
JACKSON GULCH
MANCOS
PLATORO
EL VADO
ABIQUIU
COCHITI
GALISTEO
JEMEZ CANYON
ANGOSTURA
ISLETA
SAN ACACIA
ELEPHANT BUTTE
CABALLO
PERCHA ARROYO
PERCHA
LEASBURG
MESILLA
MATHEWS CANYON
PINE CANYON
MOJAVE RIVER
SAN ANTONIO
EL CAPITAN
HENSHAW
Soda Lake
Bristol Lake
Rogers Lake
Owens Lake
Laguna Salada
Salton Sea
BLUE MESA
CRAWFORD
SILVER JACK
UNCOMPAHGRE
Gunnison
Dolores
Fremont
Dirty Devil
San Juan
Little Colorado
Zuni
Puerco
Mimbres
San Pedro
Santa Cruz
Virgin
Muddy
Grand Wash
Kanab
Chinle
Laguna Creek
Moenkopi Wash
Meadow Valley
White River
Rio Grande
SAN LUIS VALLEY

(Continued from page 11.)

Observed Irrigation

Impressed by the Mormon organization in Utah, which had successfully brought about irrigation of the valleys bordering the Wasatch Mountains, Powell recommended that this type of cooperation be emulated throughout the arid region. In the 1870's he sent specialists Grove Karl Gilbert and Clarence Dutton to make detailed observations in Utah. The problems in the West, as Major Powell saw them, were that individuals were gaining monopoly of water, which was much more important than the monopoly of land.

Powell's thoughtfulness, his knowledge of various subjects and his faith in technical developments of the future were ahead of his time, as shown in one of his articles in the *North American Review* in 1889:

"In all of this country wherever agriculture is prosecuted, dams must be constructed and the waters spread upon the lands through the agency of canals. As the season of growing crops is comparatively short—in most of the country it lasts from 2 to 3 months only—the waters of the nonirrigating season will run to waste unless they are stored in reservoirs.

". . . In the region of country where land is more abundant than water, the value inheres in the water, not in the land. . . if the water right is dissevered, the land is valueless. . . . All of the early civilization of the world began in arid lands, and the best agriculture of the world today is carried on by means of artificial irrigation.

". . . Ultimately one of the great agricultural regions of this country will be found in the irrigated plains and valleys of the West. Sagebrush plains, sand-dune deserts, and alkaline valleys will be covered by gardens, fields, and groves, all perennially fertilized from thousands of mountain lakes."

Spoke Boldly

Also in 1889 Powell appeared before the North Dakota Constitutional Convention and spoke boldly to the delegates with this statement:

"Years will come of abundance and years will come of disaster, and between the two the people will be prosperous and unprosperous, and the thing to do is to look the question squarely in the face and provide for this and for all years.

". . . you are to depend hereafter in a great measure on the running stream . . . All other wealth falls into insignificance compared with that which is to come from these lands from the pouring on them of the running streams of this country. Don't let these streams get out of the possession of the people . . . The property should be in the land, and the right to the water should inhere in the land and no company or individual should have property in the running streams."

In 1890 Powell wrote a series of articles for *Century Illustrated Monthly Magazine.* In these he stated:

"Not only must these lands be redeemed because of the wants of the population of that country, they must be redeemed because they are our best lands . . . We of the East must recognize that . . .

". . . By the use of all the perennial streams during the season of irrigation, by the storage of the surplus water that runs to waste in seasons when irrigation is not practiced, by the impounding of the storm-waters, by the recovery of the floods accumulated in valley sands, and by the utilization of the artesian fountains, a vast area of arid lands will ultimately be reclaimed, and millions of men, women, and children will find happy rural homes in the sunny lands.

"When the waters are stored in the mountain lakes, and the canals are constructed to carry them to the lands below, a system of powers will be developed unparalleled in the history of the world. Here, then, factories can be established, and the rivers be made to do the work of fertilization, and the violence of mountain torrents can be transformed into electricity to illumine the villages, towns, and cities of all that land."

Makes Point Clear

Powell continued to try emphatically to impress those who maintained that the West was not a desert and did not need irrigation. In 1893, at a meeting of the International Irrigation Congress in Los Angeles, Powell stated:

"I wish to make clear to you . . . there is not

One of the crew, left, and Indian rest at DeChelley ruins.

Green River railroad terminal.

Two men of the expedition take positions perilously near the cliff to make notes about the river and red chasm.

enough water to irrigate all the lands . . . there is not sufficient water to irrigate all the lands which could be irrigated . . . only a small portion can be irrigated . . . . It is not right to speak about the area of the public domain in terms of acres that extend over the land, but in terms of acres that can be supplied with water . . . .

"Gentlemen, it may be unpleasant for me to give you the facts, and I hesitated a good deal . . . but I finally concluded to do so . . . A few years ago the question arose whether all the land could be turned over to cattlemen for cattle ranges . . . I spoke again and again begging that these lands might be held for irrigation, that the lands should not be turned over to individuals for cattle ranges . . . . The people howled at me because I wasn't interested in the broad horn-problem.

"Now you are speaking for irrigation . . . what matters it whether I am popular or unpopular. I tell you, gentlemen, you are piling up a heritage of conflict and litigation over water rights for there is not sufficient water to supply the land."

Colorado River Development

Although it is quite apparent that Major Powell had only a partial concept of dam building on the Colorado River when he made his voyage, Frederick Dellenbaugh says that at least the idea was talked about by members of the expedition of 1871–72:

"I had an idea of making dams in the Grand Canyon, but not for power—merely to make it possible to navigate. My plan was to tunnel side cliffs and then blow the cliff off into the river with dynamite! People laughed at me, but I enjoyed talking about it anyway."

A short time later Powell did realize that developments on the Colorado surely were possible, provided only that the tremendous amounts of money be obtained to build the structures:

"The region below the canyon on each side of the Colorado is one of great aridity with an annual rainfall of not more than 3 or 4 inches. It

is also a region of high temperature in summer, and it has almost a frostless winter. Here, date palms flourish with a luxuriance never known in Egypt; oranges, lemons, pomegranates, and figs grow and bear in abundance, and the lands are well adapted to sugar and cotton.

"On the west lie Nevada and California. On the east Arizona stretches away to the summit of the Rocky Mountains. The lands to which the waters can be taken greatly exceed the area that can be served. How shall they be divided? The low flood plain along the river is narrow, and only small tracts within it can be redeemed.

"If the waters are to be used, great works must be constructed costing millions of dollars, and then ultimately a region of country can be irrigated larger than was ever cultivated along the Nile, and all the products of Egypt will flourish therein."

Competence Needed

After the Johnstown Flood in 1889, Powell had some rather pointed things to say about builders who construct their water works without enough design data:

"In American engineering, that which has been most neglected is a precise determination of the duty of the dam—the conditions which it must fulfill or else be destroyed. . . .

"To neglect the essential facts is to be guilty of criminal neglect. The history of mountain-lake construction, throughout all the countries of engineering enterprise, is full of lessons like that taught at Conemaugh (Johnstown, Pennsylvania), and the lessons have always been enforced by the destruction of property and life; they have always been emphasized by dire diaster.

"Modern industries are handling the forces of nature on a stupendous scale. The coal-fields of the world are now on fire to work for men; chemical forces, as giant explosives, are used as his servants; the lightnings are harnessed and floods are tamed. Woe to the people who trust these powers to the hands of fools."

Municipal and Industrial Water

Powell could see that reclamation was needed not only for irrigation on farm lands but also to supply the needs of growing cities in the West:

". . . health in the waters of the heavens; and the people must have pure water. The demand for highland waters for such purposes is rapidly increasing. The speedy development of city and town life under the new industrial conditions makes this one of the most important uses to which water can be applied. Wherever the houses of men are clustered reservoirs or systems of reservoirs must be built. Nothing can be more certain than that the storage of water for this purpose will greatly and quickly increase throughout the United States."

Hydro Energy

Although hydropower was still in its infancy Powell could see that dams could be made to supply this energy:

". . . it is probable that the resort to water-power will rapidly increase in the immediate future. It certainly will if the dream of modern electrical science is realized, so that waterpower can be economically converted into electric power and transported from place to place. If this is done,—and its accomplishment is hardly to be considered Utopian,—all our highland streams will immediately become of value as powers, and dams and reservoirs must be constructed in far greater numbers than in the past."

Weather Modification

Powell was thoroughly convinced that weather modification was a waste of time—at least as it was practiced in the 19th century according to the *North American Review* in 1892:

"Before science can do anything of value to man in the control of winds and storms it must

An airplane recently taking part in a weather modification experiment—a potential not envisioned by Powell.

:arn to control powers of a magnitude almost eyond human imagination."

Government Participation

While Powell was Director of Geological Surey from 1881 to 1894 he advocated government wnership of the water, government survey and ind classification. However, he advocated only rivately financed reclamation works.

But Federal government participation in the onstruction of reclamation works was a logical evelopment. In 1897 Captain Hyrum M. Chitenden of the Corps of Engineers made a survey or reservoirs in Colorado and Wyoming, and n his report he proposed that the government onstruct the reservoirs, administer the distriution of water, and leave the states to manage he matter of irrigation. Walter Webb in *The Great Plains* states:

"We have seen that irrigation in the West vent through five well-defined stages: individalistic, corporate, district (as advocated by Major Powell), state (as under the Carey Act), nd national (as expressed in the Reclamation Act of 1902). The tendency has been for the unit of organization and administration to exand until it became the nation itself working hrough the Bureau of Reclamation."

It was observed in the latter part of his career hat Powell felt there should be Federal Reclanation projects.

According to W. C. Darrah, author of *Powell f the Colorado*, Major Powell conceded agreenent with President Theodore Roosevelt's mesage to Congress in 1902 urging Federal governnent assistance in irrigation. The President aid: "It is as right for the national government o make the streams and rivers of the arid region iseful by engineering works for water storage s to make useful the rivers and harbors of the iumid region by engineering works of another ind."

In commenting about the President's mesage, Major John Wesley Powell said to his ephew, Arthur Powell Davis: "These things ake time, Arthur. You must learn to control mpatience, but always be impatient."

Appraisals Note Powell Gains

(Continued from Inside-Cover)

"Owe Legacy of Government Initiative"

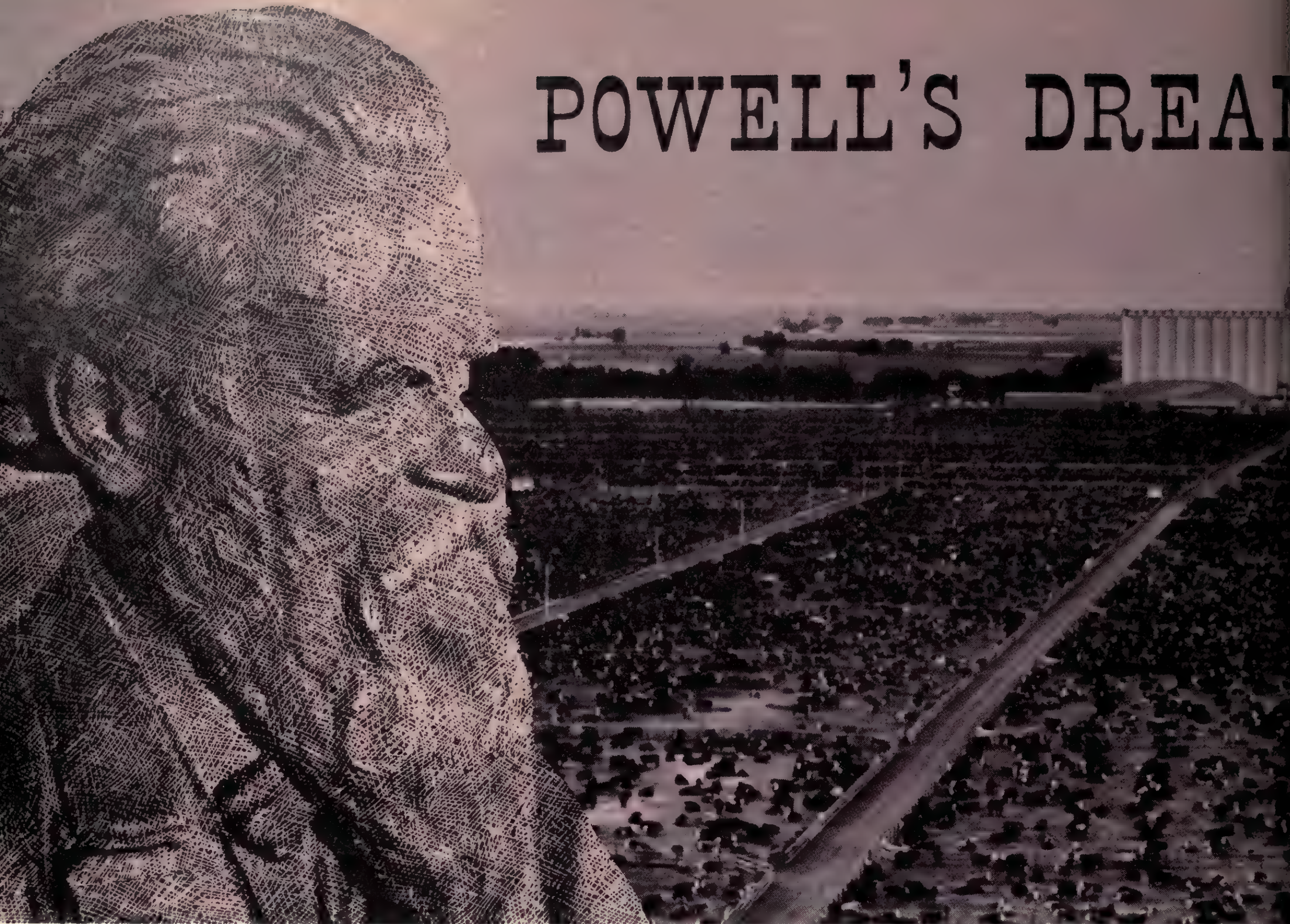
"The country owes thanks to Major Powell for his courage and audacity in running the Colorado River, the first scientific exploration of the passes south through the Rockies in 1869, and for his integrity and vision in the years that followed. To his shrewd talent as the builder of an expanding bureaucratic empire, without which his knowledge of the land and water would have been of little value to the Nation, we also owe the legacy of government initiative to preserve and protect its resources.

"His most valuable, as well as best known government publication was *Report on the Lands of the Arid Regions*. The report was the first step toward comprehending the necessity for scientific and realistic government management of the public domain and toward the encouragement of those same factors in the private management of private lands in the West. After its publication, there was no longer any excuse among learned men for the popular myth of 'rain following the plow', or the widely accepted notion that the arid lands of the West were adaptable for Midwest farming.

"The report specified that water was the key to land use and that the sharply limited supply demanded classification of land for use and management. Few government reports have stood so well the measure of hindsight.

"Although it is common for latter-day commentators to bewail the failure of the country to adopt the Powell recommendations for the western lands, a more realistic attitude might be one of thanks for the long-range guidelines which they laid down in a day when so little foresight was being shown. Tragically, much land and water resources were still to be destroyed, but the Powell recommendations were to become the basic philosophy of progressive federal conservation policy for the next two generations."—Frank E. Smith ("The Politics of Conservation," Pantheon Books, 1966).

POWELL'S DREA[M]



After the Civil War some veterans of that bitter conflict looked West for the promise of a future. Among them was Major John Wesley Powell, the steel-nerved Union soldier who in 1869, undertook scientific exploration of the Colorado River.

What Major Powell saw on that momentous trip were treacherous, narrow canyons cut through forbidding, cold mountains in upper reaches. Downstream, he saw desert—a lonely land of a few isolated settlements, a handful of Indian shepherds with their charges, lizards, and some hardy wild animals.

This man, however, saw not only the barbaric beauty of the land and the river; he envisioned ahead great agricultural developments and communities which would welcome throngs of settlers from the East.

Although the resourceful Powell did not at that time foresee great dams on "Old Red" to control the sometimes raging, sometimes meandering current, the idea of controlling and utilizing its waters was significant to him. He cherished such thoughts and later he spoke strongly on the subject regarding the entire arid West. In 1890 he wrote about the Colorado in the *Century Illustrated* magazine: "The low flood plain along the river is narrow and only small tracts within it can be redeemed. If the waters are to be used, great works must be constructed costing millions of dollars, and then ultimately a region of country can be irrigated larger than was ever cultivated along the Nile, and all the products of Egypt will flourish therein."

With his understanding of land, water and ecology—far ahead of his time—the Major possibly envisioned the kind of development which is taking place in the Colorado Basin now. The sparsely settled plains and deserts that Powell and his party studied in 1869 and later, now comprise huge prospering areas of

)ME TRUE

LOUISE LOVE, Washington, D.C.

Many uses of "Old Red's" water at this time

This huge beef cattle operation is at Greeley, Colo.

›roductive farms, thriving communities, humming industries, and great outdoor playgrounds.

I00 Dams

Dotted along that river and along its main ributaries are more than 100 dams which conrol the erratic Colorado and store water for rrigating fertile farms and other uses. The stored water is released for quenching thirst, watering lawns, filling swimming pools of the of the communities, and generating electric power to light homes and turn the wheels of ndustrial plants. To the manmade lakes, thousands of visitors come to admire and to boat, swim and fish.

Today more than half as many people live n the Western States, through which the Colorado flows, as dwelt in all of the United States when Major Powell made his famous odyssey down the Colorado.

At that time the river was the harsh master of fate for those who dwelt along its banks—but Reclamation development as Powell envisioned—has made it the servant of man.

It was along its southern reaches that development of the river began, actually dating back to the early Christian era. The Hohokam Indians dug ditches to divert water from the Salt River onto the dry land alongside, where they grew crops.

Centuries after the Hohokams disappeared from the scene, American frontier farmers again brought water from the Salt out onto the parched plains of Arizona. A small irrigated crop was harvested there just the year before Major Powell made his famous trip down the river—a token second birth of reclamation on a small part of the central Arizona desert.

But the descendants of the 19th Century pioneers who built the Salt River canals did their homework. They sought the help of Washington, D.C. where the forthright utterances and scientific exploits of Powell had become an influence. Powell's strong leadership in regards to large scale use of water and land helped launch the reclamation era for America.

The willing Arizonans were anxious to receive Federal financing and improved irrigation techniques for use against the desert, and they were first to benefit by the creation of the Federal reclamation program. Under the historic U.S. Reclamation Act of 1902, the Salt River development project was among the first to be started.

Early 1900's Challenge

Builders who constructed Reclamation works in the early 1900's found conditions challenging. The project's first major structure—Theodore Roosevelt Dam—had to be built in the tortuous canyons of the Salt, 65 miles by horse and wagon from the railroad terminal. The task was Herculean in scope, but the structure—America's largest masonry dam—was completed in 1911, and still massively blocks the Salt River gorge.

Five other dams subsequently have been built on the Salt and its tributaries. They are successfully operating today, furnishing water

for irrigation of 234,000 acres of land, for municipal and industrial water supply, hydroelectric generation, and recreation. This desert area has become a leading vacation and industrial complex in the Southwest.

Other reclamation project areas have developed similarly. In 1904 Powell's nephew, Arthur Powell Davis, an engineer for the budding United States Reclamation Service—as it was then known—conceived a broad proposal for development of the lower Colorado under unified control of the Federal Government, with a great dam to store floods and to serve as the heart of the project.

The "great dam"—Hoover Dam—was built much later, but construction on a Federal reclamation project for the Yuma, Arizona, area was started in 1905. From this unit the first Reclamation-developed water was delivered. Today about 70,000 acres in the Yuma project and its auxiliary unit receive Colorado River water to irrigate cantaloups, winter vegetables, small grains, and citrus fruits.

Water is delivered to the distribution system by the All-American Canal, which also serves more than half a million acres of rich farmlands in California's Imperial and Coachella Valleys.

Keystone of this Colorado River development—the granddaddy of all multiple-purpose river control structures—is Hoover Dam. Built in the 1930's at the Nevada-Arizona border as the key feature of the Boulder Canyon Reclamation Project, this engineering marvel of concrete changed the river from a menace to a blessing. Since Hoover Dam started storing water in 1935 there has not been a flood of any consequence nor a drought in the project-served lower basin.

Hundreds of throusands of people every year take the guided tour to see this structure, still the second highest dam in the Western Hemisphere. Its reservoir, Lake Mead, which stretches 115 miles upstream, stores enough water to inundate the entire State of Virginia to a depth of one foot

To Nevada Project

Construction has begun on the newly authorized Southern Nevada Water project. Its major feature is a four-mile tunnel through the River Mountains which lie between Lake Mead and the Las Vegas Valley.

Further regulating the Colorado to perform its life-sustaining services to the people of the lower basin, the Bureau of Reclamation built multi-purpose Davis and Parker dams.

Davis, 67 miles below Hoover, produces electric power, reregulates releases from Hoover, and assists in regulating the river's water deliveries to Mexico in accordance with the Mexican Water Treaty.

Parker, 88 miles farther down, provides a forebay and desilting basin for the Colorado River Aqueduct of the Metropolitan Water

Grove in Imperial Valley, Calif. gets crop between rows. Top left. Reservoir recreation area, Blue Mesa Dam, Colo. left. Visitors atop Flaming Gorge Dam, Utah.

District of Southern California, which carries municipal and industrial water to the Los Angeles-San Diego megalopolis. Both dams impound reservoirs that furnish superb outdoor recreation and enhance fish and wildlife habitat.

Three hundred miles below Hoover, Imperial Dam diverts water from the river into the All-American Canal and the Gila Gravity Main Canal, the service areas of which comprises some of the most fertile farmland on the continent. Crops valued at more than $4 billion have been grown on these high-productivity lands.

For many years prior to the 1956 authorization of the Colorado River Storage Project, upper basin states had to watch precious Colorado River water flow through their dry lands largely unused, while their fields lay parched alongside and progress, based upon water resources, passed them by. Now, however, three of four planned storage units are completed and a vast 5-State development program is well underway.

In northern Utah, Flaming Gorge Dam regulates the flow of "Old Red's" chief tributary, the Green River. It was Major Powell who aptly named the gorge for its flaming red walls. Today, where the Powell party approached the head of "the first canyon we are to explore," this majestic dam has impounded a scenic lake which already is rated one of the great reservoir fisheries of the West. Stretching 91 miles upriver, far into Wyoming, it also offers boating, water skiing, and swimming to its throngs of visitors.

A 108,000-kilowatt Flaming Gorge powerplant generates hydro-electricity to help pay project costs.

On The Gunnison

In Colorado on another tributary, the Gunnison River, the Bureau of Reclamation is presently building the Curecanti Storage Unit. Blue Mesa Dam, with a 60,000-kilowatt powerplant, began commercial operation in 1967. Its reservoir, situated between the perpendicular walls of fabulous Black Canyon, is the largest lake in the State of Colorado and attracted more than 182,000 visitors in 1967.

Just recently completed 12 miles downstream from Blue Mesa is the Morrow Point structure. This landmark dam incorporates a free-fall spillway which creates a waterfall about twice as high as Niagara Falls. The powerplant, 225 feet deep in the canyon's rock wall, is under construction. Curecanti's Crystal Dam, reservoir, and powerplant are authorized for construction further downstream.

On the San Juan tributary in northern New Mexico, Navajo Dam and Reservoir is the main feature of the Navajo Storage Unit. This earthfill structure makes possible diversion of water for irrigation on the Navajo Indian Irrigation Project.

Major storage unit of the Colorado River Storage Project is Glen Canyon Dam, just a few miles north of the Lees Ferry landmark in Arizona. Here majestic Glen Canyon Dam stands as the final guardian of Colorado River water for the states of the upper basin. Selected by the American Society of Civil Engineers in1964 as the outstanding engineering achievement of the year, Glen Canyon rises 710 feet above bedrock between multi-colored steep canyon walls.

The river in this canyon remained much as it was when Major Powell viewed it—and christened it Glen Canyon—until the 1950's when modern Paul Bunyans arrived with bulldozers and dynamite to force a giant concrete plug between the walls. The reservoir which Glen Canyon Dam impounds has been named for the famous explorer, who left us the

first detailed description of Glen Canyon. Lake Powell has been described by former Interior Secretary Stewart L. Udall as "the most beautiful man-made lake in the world."

Backing up 186 miles behind the dam, the jewel-like Lake Powell ventures watery fingers into dozens of side canyons hidden through the ages from all but a few human eyes. A visitor center, marinas, and other public facilities have been built to accommodate the thousands of visitors who are being attracted to this unusual wonderland.

Scenic Values

While the Glen Canyon Storage unit is affording visitors incomparable views, glorious boating, and excellent fishing—not only in the lake but in the now clear-flowing stream below the dam—its 900,000-kilowatt powerplant is generating hydropower that ultimately will meet the lion's share of the expenditures for construction of the facilities and for other basin development to come.

Six participating projects or units of projects have been completed in the upper basin to irrigate farming in Utah, Colorado, and New Mexico. Sixteen others are under construction, in planning stages, or recently authorized in these states and Wyoming. When these units are all in operation, they will supply irrigation water to nearly 875,000 acres of land.

One of the participating projects presently under construction is the San Juan-Chama in Colorado and New Mexico. The development involves a transmountain diversion via Azotea Tunnel, which recently was "holed through" under the spine of the Continental Divide. On the eastern slope of the Divide, construction is underway on Heron Dam, which will impound water to be transported for municipal use in the city of Albuquerque and for irrigation of farms in the Rio Grande basin.

Since authorization of the Colorado River Storage Project (CRSP) in 1956, about $715 million of Federal funds have been expended on dams, reservoirs, powerplants, transmission systems and other [illegible]ilities of the five-state project. About 9[illegible] percent of this sum will be paid back to t[illegible]ed States Treasury by water and power u[illegible]

The CRSP is the comprehensive framework within which the upper basin is developing its water resources. However, several decades before this project was authorized, an ambitious plan evolved in Colorado to permit that State to utilize on the arid plains east of the Divide some of its Colorado River water naturally flowing down the western slope of the Rockies.

First Transbasin Tunnel

Finally authorized as a Federal Reclamation project in 1937, the Colorado-Big Thompson project was one of Reclamation's major transbasin water diversions. A milestone accomplishment, this project—having a 13.1-mile-long water tunnel through the Continental Divide—last year marked 21 years of growth since initial delivery of water. The project is operaged by the Northern Colorado Water Conservancy District, and the dollar value of crops produced for the farmer and livestock feeder, has risen from about $63 million in 1951 to about $95 million in 1967.

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)

IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

The "Big-Tom" project provides water and lectric power for use in many communities, nd its reservoirs make available healthful, vater-based recreation opportunities to nearly million people per year.

Today the Bureau of Reclamation is contructing another trans-mountain diversion project in Colorado, the Fryingpan-Arkansas Project, which will develop long needed multiourpose water supplies for both the Colorado nd Arkansas River basins.

In the upper (northern) basin development, ome 40 additional proposed subdivisions of he Colorado River Storage Project are being tudied with a view to putting to use a large part of the remainder of the water allotted to he 5 States involved.

A crowning achievement in development of the Lower (southern) Colorado River Basin will be the Central Arizona Project, authorzed by Congress last September. The culminaion of nearly 20 years of hard, and frequently discouraging, efforts by basin residents, and ocal, State and Federal officials, the $932 milion project is a bright promise of further water usefulness and prosperity in Central Arizona.

The river gorge areas from Glen Canyon to Lake Mead—which John Wesley Powell was he first man to traverse—has been left without developments. It and the rest of the basin's highly scenic rivers and streams are magnificent fresh-air playgrounds for sports and naure buffs, and inspiring outdoor classrooms or Americans of all ages.

Such benefits and the ultimate wise utilizaion of the West's land and water resources will bring to fruition the dream of Major Powell, and the visions of many people through the years. Meantime, much work remains to be done—to plan, fund, and build facilities still needed.

Thomas Jefferson once said, "The face and character of our country are determined by what we do with America and her resources." Probably the prime illustration of the great patriot's premise is the extraordinary development of the Colorado River—a goal of the extraordinary leader in Reclamation.

Powell's Career Highlights From 1869

The daring Major Powell was 35 when he led a party of 10 men, in 4 boats, down the canyons of the Green and Colorado Rivers, largely self fininanced, in the summer of 1869. (His earlier life is noted on pages 1 through 4.)

In 1870 Congress established the Geographical and Geological Survey of the Rocky Mountain Region with Powell in charge.

In 1871–1872 he led his second exploratory voyage down the Green and Colorado Rivers.

From 1870 to 1879 he directed the survey and mapping of the "Plateau Province" which had been opened up by the 1869 expedition. Powell and the men he took with him mapped and named Glen Canyon and many other features in the region.

In 1879 he took a leading part in establishing—was one of the founders of—the U.S. Geological Survey while, himself, becoming Director of the Bureau of Ethnology in the Smithsonian Institution.

In 1881 he succeeded Clarence King as Director of the Geological Survey.

From 1888 to 1891, he conducted the Irrigation Surveys which became the basis of the Reclamation Service created in 1902, to be called the Bureau of Reclamation a few years later. He was, in effect, one of the founders of this agency.

He resigned as Director of the Geological Survey in 1894, but continuing as Director of the Bureau of Ethnology. Died at age 68, September 23, 1902, at his summer home in Haven, Maine. Buried in Arlington National Cemetery, Arlington, Va. # # #

VISITOR CENTER AT GLEN CANYON DEDICATED

The $1.2 million Carl Hayden Visitor Center overlooking Glen Canyon Dam in Arizona, shown in the photograph, was dedicated last September 26. Secretary of the Interior Stewart L. Udall gave the dedicatory address. Commissioner of Reclamation Floyd E. Dominy was Master of Ceremonies. The new visitor center—a joint effort of Reclamation and the National Park Service—was begun in 1965 and completed in 1967. A sculptured bust of the recently retired Arizona Senator Hayden will be installed near the entrance.

National Wildlife Week

"Provide Habitat—Places Where Wildlife Live" will be theme for the 1969 observance of National Wildlife week March 16–21, according to the National Wildlife Federation.

AIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. DOCS.	

Enclosed find $______________ (check, money order, or Documents coupons). Please enter m
ubscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents pe
ngle copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code______________________________

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
C-6672	Missouri River Basin, N. Dak.	Oct. 10	Construction of Killdeer substation, stage 01	United Power, Contractors and Engineers, Inc., Seattle, Wash.	$396,858
C-6675	Southern California Edison Company, Nev.	Oct. 2	Construction of River pumping plant for Southern California Edison Co. Mohave generating plant.	Oakland Construction Co., Inc., Salt Lake City, Utah.	188,238
C-6676	Missouri River Basin, Iowa.	Nov. 13	Construction of stage 07 additions to Sioux City substation.	Addison Construction Co., Cheyenne, Wyo.	111,253
C-6677	Southern Nevada Water, Nev.	Oct. 9	Construction of 7.5 miles of Boulder City lateral	Hood Corp., Whittier, Calif.	1,156,204
C-6680	do	Nov. 5	Construction of pumping plant No. 1A, forebay No. 1A and switchyard No. 1A.	S. S. Mullen, Inc., Seattle, Wash.	2,886,881
C-6681	Central Valley, Calif.	Oct. 9	Construction of pipe portions of five canal crossings and one canal and road crossing for San Luis drain.	Oscar C. Holmes, Inc., and Holmes-Clair, Inc., Menlo Park, Calif.	367,820
S-6684	Colorado River Basin Pilot, Colo.	Nov. 6	Ground-based instrumentation network and surface meteorological data collection for supporting weather modification research in Colorado. (Negotiated Contract)	Western Scientific Services, Inc., Fort Collins, Colo.	695,916
C-6685	Central Valley, Calif.	Oct. 17	Relocation and bituminous surfacing of 2.8 miles of Auburn-Foresthill county road.	O. K. Mittry & Sons, Gardena, Calif.	1,326,648
C-6687	Columbia Basin, Wash.	Nov. 26	Construction of administration building for Grand Coulee third powerplant.	George A. Grant, Inc., Richland, Wash.	719,795
C-6692	Paonia, Colo.	Nov. 26	Rehabilitation of Colorado Highway No. 133 near Paonia, Colo.	Mile High Drilling Co., Inc., Wheatridge, Colo.	272,262
C-6693	Central Valley, Calif.	Nov. 29	Preconsolidation of lateral 7R, Sta. 189+54.9 to 376+97.4, and reservoir and pumping plant sites for Westlands Water District distribution system.	Industrial Pipelines Intermountain, Inc., Murray, Utah.	279,174
C-6695	Pacific Northwest-Pacific Southwest Intertie, Nev.	Dec. 12	Construction of a million-gallon concrete water storage tank and 1.6 miles of auxiliary waterline for Mead substation.	TAB Construction, Inc., Las Vegas, Nev.	242,900
0C-1014	Columbia Basin, Wash.	Oct. 16	Construction of 3 miles of compacted blended earth lining for existing laterals, supplemental construction and modification of existing structures, Blocks 85, 86, 87 and 89.	Clark F. Cass & Walt Alloway, Moses Lake, Wash.	115,990
0C-1017	do	Nov. 4	Construction of 13.9 miles of buried pipe drains for D75-36, D75-72 and D75-87 drain systems and D75-87D pumping plant, Block 75.	Equipco Contractors, Inc., Ephrata, Wash.	257,435
0C-1018	do	Oct. 16	Construction of 7.9 miles of buried and .25 mile of open ditch drains for D85-99 and D-85-114 drain systems, Block 85.	Clark F. Cass & Walt Alloway, Moses Lake, Wash.	151,153
0C-1019	do	Oct. 21	Construction of 2.1 miles of concrete lining for laterals, 4.3 miles of buried pipelines and structures for W3F laterals, Block 70.	Peters and Wood Co., Pasco, Wash.	302,696
0C-1020	do	Oct. 8	Construction of 5.6 miles of buried pipe drains for D20-212-2 drain system, Block 20.	Equipco Contractors, Inc., Ephrata, Wash.	147,964
0C-1021	do	Oct. 21	Construction of 19.6 miles of buried pipe drains for Blocks 18 and 47.	M & J, Inc., Moses Lake, Wash.	299,713
0C-721	Central Valley, Calif.	Oct. 1	Construction of Red Bluff park, including picnic area, paving picnic and parking areas and landscaping for Red Bluff diversion dam.	James E. Byrne, Red Bluff, Calif.	113,304
0C-728	do	Oct. 2	Rehabilitation of 14 timber bridges along Friant-Kern and Madera canals.	Hertel Construction Co., Inc., Sacramento, Calif.	271,275
0C-729	do	Oct. 14	Removal of five and rehabilitation of three timber bridges and concrete lining canal extensions between Miles 70.01 and 116.5, and rehabilitation of pipeline crossings between Miles 85.0 and 110.3 for Delta-Mendota canal.	Oscar C. Holmes, Inc., and Holmes-Clair, Inc., Menlo Park, Calif.	737,366
0C-730	do	Nov. 12	Relocation of Pacific Avenue, including overpass and Boardman canal siphon, in Auburn, Calif.	Thomas Construction Co., Fresno, Calif.	327,182
0C-734	do	Nov. 6	Construction of parking area and related features for Auburn dam temporary overlook.	Sutherland Construction, Inc., Auburn, Calif.	129,180
0C-393	Weber Basin, Utah	Oct. 24	Construction of 4.8 miles of concrete lined Willard laterals, 1.8 miles of open and 1.5 miles of closed Plain City area C drains, Schedule II.	Ray W. Coleman, d.b.a. R. W. Coleman Construction Co., Brigham City, Utah.	263,806
0C-278	Pecos River Basin Water Salvage, N.M.	Nov. 12	Clearing Pecos River from McMillan dam to New Mexico-Texas state line.	Armstrong and Armstrong, Roswell, N.M.	238,000

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

. . . mirrored beauty and inviting pastimes—welcoming at every turn around the huge new man-made lake named after Major Powell in Arizona and Utah.

May 1969

RECLAMATION

era

A WATER REVIEW QUARTERLY

May 1969 Vol. 55, No. 2

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER PHOTO. Fresh from irrigated field, this January harvest of carrots gets a good washing. Farmers' earnings from vegetables were $1.6 million last year on this Lower Rio Grande project.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Floyd E. Dominy
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

Forward Together

My selection by President Nixon as Secretary o the Interior affords a real opportunity to further my in terest in the conservation and utilization of America great publicly owned natural resources. Because of th potential of enhancing the life of every American, no and for future generations, I anxiously take up the cha lenge of the Department of the Interior programs.

I firmly believe the Nation's strength and pro ductivity is solidly tied to wise conservation—wise man agement and protection of our water, land and miner resources—and the outdoor recreation opportunities whic our public lands offer a nation seeking relief from ove urbanization.

In defining our programs and problems, we mu guard against the tendency to over-complicate the wor "conservation." In essence, it means to take care of and u in the best manner possible, the vital resources of this eart for man's benefit and for all posterity.

In his remarks to the Department of the Interi employees shortly after assuming office, President Nixo forecast a role of "action" and progress in wisely develo ing the Nation's resources: "This great rich land will d velop, in the years ahead, the resources—clear air, pu water—which our children will want to live in," he sai "I don't know of any Department that will have more an effect on what kind of a country we are going to ha than the Department of the Interior."

Because there is no more basic catalyst in the u of our resources than our water supplies, let us keep hig hopes for their best development and use; let us join forc and go forward together.

Walter J. Hickel

WALTER J. HICKEL
Secretary of the Interi

Secretary of the Interior Walter J. Hickel.

Walter J. Hickel Heads Interior

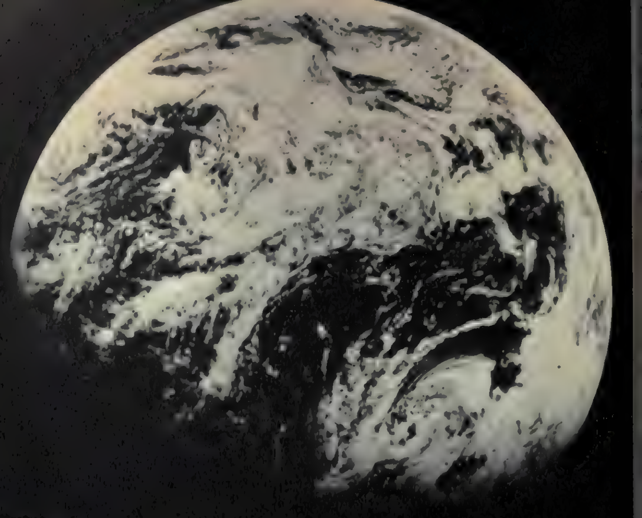
Walter J. Hickel, former Governor of Alaska, heads the Department of the Interior as Secretary in the Cabinet of President Richard M. Nixon.

Secretary Hickel came up the hard way in Alaska where he arrived as a young man with 37 cents in his pocket. He became a leader in real estate construction and became the first Republican Governor of the new State 2 years ago.

He is a native of Kansas, the oldest of 10 children of a farm family near Claflin.

His first field visit after becoming Secretary was to a State Reclamation Association meeting in North Dakota and to the Federal Center in Denver where he spoke to massed Interior employees in the Reclamation Engineering Research laboratory.

Russell E. Train, former president of the Conservation Foundation, has been named Under Secretary and James Smith of Omaha, Nebr. has been appointed Assistant Secretary for Water and Power. Mr. Smith was manager of marketing relations for the Northern Natural Gas Co.



PACE AGE AND /ATER CONSERVATION

by **FLOYD E. DOMINY, Commissioner of Reclamation**

IN ONLY 9 years—the length of time since the first human space traveler was launched into orbit—American technology has developed at a tremendous speed. This is not science fiction. It is accomplished fact. Many astonishing results of this Space Age technological revolution are here or in advanced stages of development, and already are affecting the lives of all of us.

The infusion of Space Age knowledge is burgeoning research efforts so much that who knows what the next decade will bring—or where it will take us? Much useful knowledge came from orbits around the earth, from sensitive devices launched into stratosphere, and on flights to the moon.

Our voyage of men to the moon last December was a great achievement of knowledge of that planet as a potential "space depot," where a vital water supply is one of the eminent sustenance problems to be met. "Spin-offs" of this research effort already are benefiting water resources development, and will continue to do so for years to come.

Astronauts have used cameras from space capsules as remote-sensing devices, obtaining photographs unprecedented in detail and scope. Results of these expanding research efforts include photographs taken off the Persian Gulf which delineate ocean depths up to nearly 120 feet. Others taken of the mouth of the Colorado River, detail the heavy buildup of sediment in the delta.

A look ahead shows unmistakeably that we are on the threshold of technological developments which will profoundly influence virtually all aspects of modern society and man's environment.

EROS Studies

Seeking to take advantage of the new avenues to knowledge and research, the Department of the Interior has established an interagency program known as EROS (Earth Resources Observation Satellite). The Bureau of Reclamation is participating in this program and has established in our Chief Engineer's office in Denver, a committee of specialists to study applications and potentialities of remote-sensing techniques to our work and to recommend these techniques for use in meeting our objectives in water resource development.

Future inputs of information from these applications will derive from the EROS satellite of the National Aeronautics and Space Administration. This NASA satellite is being designed, and will be orbited for the sole purpose of obtaining earth-oriented resource data.

As these orbiting remote-sensing devices are perfected and put into use, they can contribute knowledge to a wide variety of earth-bound problem areas. For example, they may be invaluable in improving snow survey and precipitation forecasting of seasonal runoff from snowpacks and storms

ken from Apollo 8 last December, the photo at left includes "good d U.S.A." in the center, and impressively shows that most of the rth is cloud covered. Clouds over the United States usually release) percent of their moisture, but because nature is an inefficient inmaker for many people's needs, Reclamation's cloud seeding forts are being designed to "milk" 10 to 20 percent more precipi-tion for areas which could beneficially handle larger amounts an they are getting.

or use in storage reservoir operations. They also nay help accomplish more detailed and precise emperature and evaporation surveys of lakes, in-luding the effect of evaporation reduction neasures.

Other potential benefits stemming from these echniques include obtaining more accurate data n cropping patterns, density of vegetative cover, oil moisture conditions, reservoir and canal seep-ge, and other data pertaining to the evaluation f water storage, and transportation, and its appli-ation on irrigation projects.

This is, in effect, a major spatial extension of he already varied types of sensing equipment now n use on automated and sprinkler irrigation arms.

'lastic Pipe

Another contribution from the Space Age re-earch has been the development of reinforced lastic mortar pressure pipe, a material previously ised in space vehicles. The Bureau of Reclamation as installed a half-mile section of this new light-veight pipe in the Westlands Water District dis-ribution system on our Central Valley Project iear Fresno, Calif. The 15-inch diameter pipe is einforced with fiberglass and is under tests to vithstand a pressure head of 325 feet of water.

Early results of this experimental installation ndicate that it will exceed, by a substantial mar-gin, all of our design requirements, and its offers singular promise for future economical usefulness n irrigation agriculture. Our evaluation, of course, waits further testing because we are interested n pipe of new materials that will favorably com-pare with concrete pipe, both on the basis of cost and ability to last for an extended period, say 50 years.

This agency continues to search out new pipe-line materials, methods and techniques, and to uti-ize those that survive our laboratory and field ests to improve our structural and operational performance and to lower costs to our waterusers.

This is important to us, because Reclamation projects have in operation more than 700 miles of pipelines, nearly 14,000 miles of canals and over 32,000 miles of laterals, including those features constructed by the waterusers.

Results of our testing, of course, are routinely made available to industry, and to any interested individuals through our technical reports and manuals.

Our 21-year-old lower cost canal lining pro-gram, reduced the cost of development of a num-ber of irrigation projects, and also made a substan-tial savings in valuable water by reducing seepage from canals and reservoirs.

Underground Systems

As a sign of the changing times, more empha-sis on saving and better utilization of water brought about a new emphasis on placing more and more conveyance systems underground. This, in turn, meant phasing out of the lower cost canal lining program last year and the establishment of our new Open and Closed Conduit Systems Program.

Estimates are that many, if not most, of the smaller laterals of the future will be in pipe, and possibly as much as 90 percent of future distribu-tion systems.

Reclamation also feels strongly about the im-

This light-weight water pipe—being installed for tests—is made of plastic mortar material first used in space vehicles.

portance of conserving water in transit from storage to irrigated lands. If we can save the 30 to 40 percent of water otherwise lost in transit and use it for municipal purposes, there will be considerable benefit to the project.

New materials and techniques for installing also are being explored for subsurface drainage, to control the water table beneath the surface of the irrigated land. Pipe will continue to be essential in drainage operations.

An outstanding example of this requirement is provided by our recently authorized Oahe Unit in South Dakota. The lands for this development lie on an old lake bed, formed during a glacial recession, and nearly 6,000 miles of pipe may be required for subsurface drainage of the project in its initial and ultimate phases.

Importing

Long distance transport of water is the subject of several reconnaissance and feasibility studies of the Bureau of Reclamation that stand to benefit heavily from modern technological progress. For example, one study is underway on the proposed importation of surplus water of the Mississippi to west Texas and eastern New Mexico, an overland distance of 1,200 miles.

Equally challenging water conveyance problems have been encountered and overcome on several of our major projects. These include the 500-mile-long system on the Central Valley Project in California from the area of supply to the area of use, the Colorado-Big Thompson Project in Colorado, a major transmountain diversion that takes water originally destined for the Pacific Ocean through a 13-mile-long tunnel under the Continental Divide into the Missouri River drainage basin; and the Canadian River Project in Texas, which delivers water to 11 Panhandle communities through a 322-mile pipeline system.

If the water is available, Reclamation has the engineering know-how today to convey the water from point of origin to the area of need, even though they may be separated by half the continent. Space Age research can give us new and improved materials and techniques, but the engineering know-how has been adequately demonstrated.

The problem of the West, however, is not only one of conveyance, it is also one of too limited water supply. So we also are endeavoring to do something about the weather—to induce precipitation in our cloud seeding research program. This weather modification program, initiated in 1962 with broad congressional support, has as its general objective, the development and adaptation of cloud "milking" techniques for augmenting streamflow, particularly by increasing snowpack above our existing reservoirs.

Limited Supply Areas

An immediate objective is to determine if operational techniques can result in feasible runoff augmentation for Reclamation projects in regions of limited water supplies. The program has reached the $4.7 million level this year, and long-term plans contemplate gradually expanding research and field efforts, with appropriations of roughly $50 million a year needed by the late 1970's. But the returns will be enormous.

Actively involved today are 37 atmospheric water research groups drawn from private industry, universities, State governments, and Federal agencies and under contract with this agency. The program includes 10 major field experiments aimed at testing and evaluating new techniques in different regions under various climatic conditions.

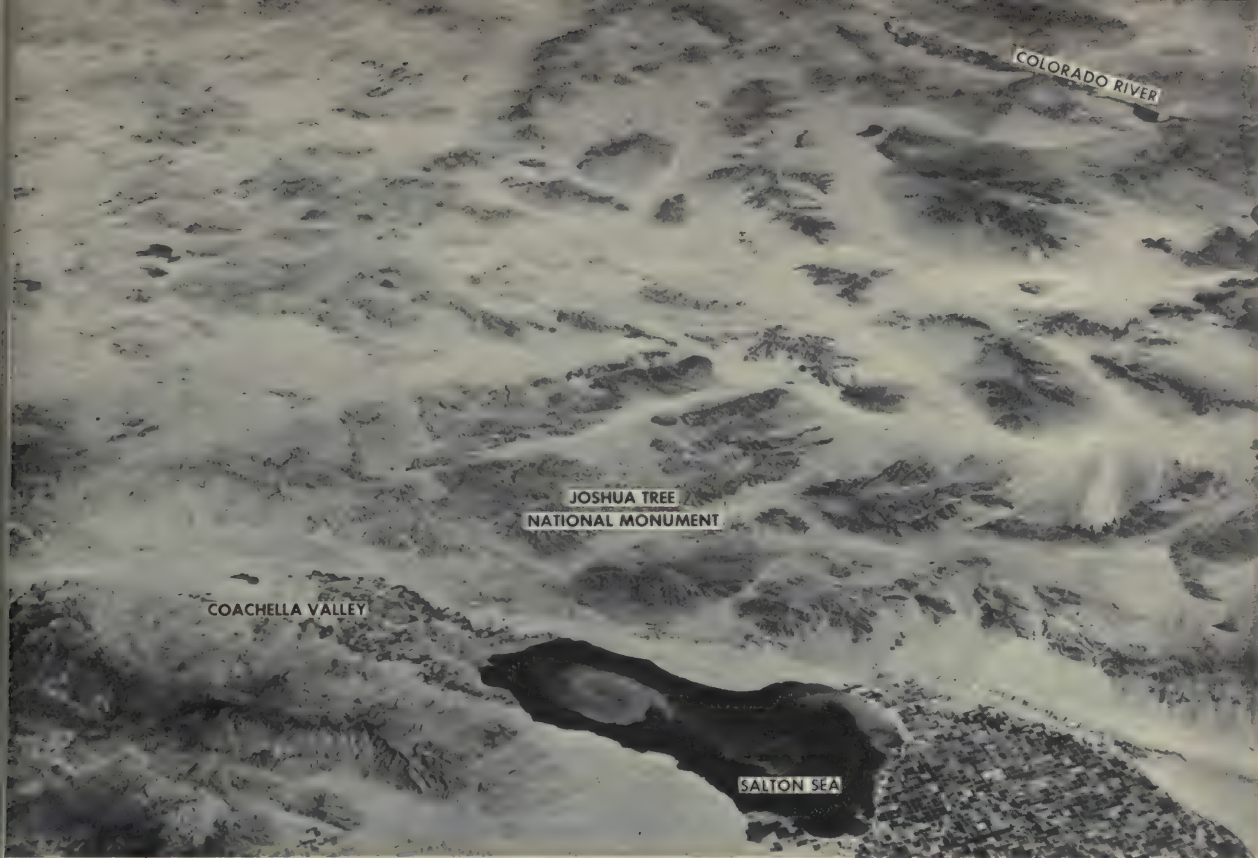
Two important pilot cloud seeding projects, one in the Upper Colorado River Basin and the other in western North Dakota, are expected to begin this calendar year. These projects will give firm answers on the feasibility of large-scale cloud seeding in those areas as early as fiscal year 1974.

In addition to trying to coax more moisture from winter storms, we are supplementing the Department-wide efforts to be a pace-setter in the national crusade to clean up our rivers and keep them clean. For years our reservoir operations have made it possible to store high quality floodflows and release these during low flow periods when the water quality would have been poorer without this supplementation. An example is the beautiful stretch of clear, trout-laden water below Flaming Gorge dam in Utah.

Quality Monitoring

Among other current efforts, the Bureau is expanding its system of water quality monitoring, one similar to its present system of measuring water quantity on our operating projects. The objective is to develop a system that will provide a base on which to detect whether there is a problem, any changes in water quality and to anticipate problems such as the anticipated water shortages.

We also are considering an expanded research program in this field, and will give increased at-



t 106 miles altitude, astronauts Cooper and Conrad took this photograph in 1965 which includes "oasis-producing" type Reclamation vater projects. One is Imperial (lower right) with half-million irrigable acres, and the other is Coachella consisting of 103,000 such acres. hey get their fresh water by aqueduct from the Colorado River, shown in top right corner, where other Reclamation facilities are: from eft, Lake Mohave, Davis Dam, town of Needles, and Lake Havasu—all 150 to 110 air-miles from Salton Sea.

ention to the use of pressure pipe in transporting vater reclaimed from polluted sources and to evaluation of the effects of return flow on potential ises downstream.

Some people who recall the Technocracy movenent will remember the forward-looking articles on farming in the future that were inspired by that group. During the 1930's these were regarded as dreams of self-contained, air-conditioned "bubble cities" as something wildly visionary and straight out of Buck Rogers.

Future Sketches

But today we see serious scientists at work planning how to build self-contained environments on the moon, complete with hydroponic (soil-less) gardens, rock-pulverizing water stills, and a continually re-circulating system of water recapture and reuse. In this age of space-walking astronauts and of city-sized air-conditioned shopping centers under one roof here on earth, we are conditioned to accept almost any far-out concept of the way we will live, farm and travel in the Space Age.

But of this we can be sure: All the scientific know-how and the billions spent in research for a few hardy souls to travel in space, and its modern technology, have not reduced the value nor the importance of the basic product that we and these space men require—water.

Next to the air we breathe, water remains our most vital resource. And while man can carry sufficient oxygen and food for a prolonged space flight, he must use and re-use all the water he can carry on his spaceship. And for the space stations being considered for eventual use, the procurement of an adequate water supply is one of the most challenging technological problems.

The Space Age is almost an incredible age. As a leading water development agency, the Bureau of Reclamation welcomes this period's more rapid progress and greater challenges, and this agency will continue its crusade of leadership for wise conservation and development of water resources for man and his expanding environment. # # #

Today's water tricks would amaze Explorer John Powell

FUN ALONG THE COLORADO

IF HE could return today, 100 years after his epic river and canyon explorations, Major John Wesley Powell would not be too surprised at finding dams and reservoirs on the Colorado River system which he knew so well.

A perceptive man, Powell knew that American technology would make far-reaching accomplishments. For instance, he envisioned tapping the West's rivers for such benefits as irrigation and community use. And he was known to predict that hydropower generation would someday be one of the primary purposes of dams.

Rapids in Grand Canyon, left, make this float trip exciting.

leasant activity, left, seen especially on weekends, goes on often at the boat launching ramp below Flaming Gorge Dam, Utah.

Nor would Powell be disappointed that the Colo-rado River and its tributary, the Green River, have not been wholly "preserved" in the condition he found them. He realized, probably better than any other man of his day, the critical value of water resources to the West's development. And he was constantly a zealous advocate of practical water purposes, whenever his story might enlighten someone.

Probably the Major would be astonished, how-ever, by the way Americans have widely accepted new pastimes at water resource areas. This does not include fishing, which has been appreciated for centuries, nor boating, which seemingly held some promise in his day for increasing variety.

But Powell scarcely could have envisioned a boom in such ideas as people being rapidly pulled across water on two small pieces of wood—water skiing; or adding both skis and a kite for soaring a few minutes in the sky.

Both of Powell's boating trips, one in 1869 and the other in 1871–72, were made in heavy rowboats, each weighing over 1,000 pounds. When danger-ous rapids were met, the preferred technique was to unload all gear and then to let down the boats with long ropes. Usually, one line was tied to the bow and another to the stern, with at least two men handling the lines.

Boat Loss

Occasionally a boat was pulled from their grasp by the swift current, and sometimes holes were knocked in the hulls by rocks, but the crew man-aged to improvise patches and to keep the boats afloat throughout the trip. In Lodore Canyon one of the explorer's boats was out of control before its occupants could make a landing, and it was broken apart by colliding with a midstream boulder.

Today's Flaming Gorge and Glen Canyon Dams, provide plenty of swift-flowing river for those who wish exciting river trips. Much lighter-weight craft, either of wood or rubber, is used today in place of the awkward boats of the Powell trip. Where rapids threaten, boaters can utilize the up-dated knowledge and experience, or they can usu-ally run the rapids—in a carefully prescribed manner—rather than make a portage or line their boats. Danger still lurks in the violent rapids, but a river runner with exact knowledge and consider-able experience can make it look easy.

Powell started his trips during May, knowing that the Green River would be high from spring runoff. The large flow carried him and his men over many hidden boulders, but it probably also contributed to the accident in Lodore Canyon when the river's swiftness threw the boat out of control.

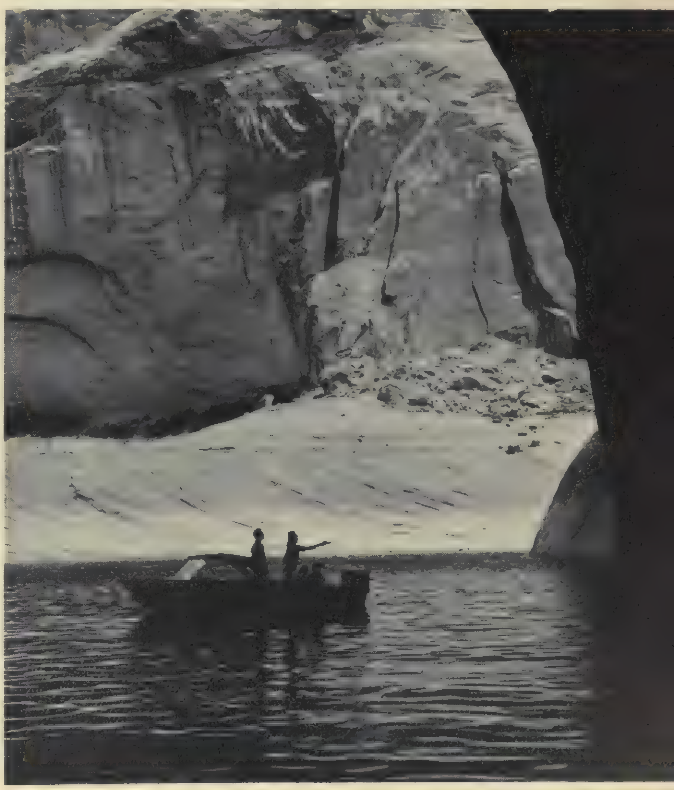
By August, when Powell was in Grand Canyon, he was riding on low flow, and the voyagers were continually plagued by high riverbed and exposed rocks.

Flows Evened

The advantage today is that Flaming Gorge and Glen Canyon Dams have evened the flows, cutting down the tempestuous floods of spring and releas-ing water gradually throughout the year, or when needed. Boating is thus possible for a long season.

In another aspect—the mobility of the American public in getting to lakes for receation purposes—

A family pauses for some peaceful fishing at the base of one of the many deep caverns in Lake Powell, named after Explorer Powell.



Powell would be amazed. A lake located more than 5 miles out of town was almost too far away for a quick fishing trip in his day—unless, perhaps, it happened to be linked to town by railroad.

Because of their remote locations, Reclamation reservoirs built in the early part of this century were rarely considered for recreational use. But with the age of transporting boats behind the automobile, people began looking to these reservoirs for their "treasure house" of potential in fishing, boating, swimming, and sightseeing.

At Flaming Gorge Lake, named for the first canyon which Powell and his men boated into, swimming has become part of the routine of even such knowledgeable wildlife as deer, when they have a hankering to be on the other side of the lake. On seeing the animals swimming across, visitors take pleasure in a good deed by reporting the swimming deer for officials of the Utah and Wyoming State Game departments.

Most visitors to the Flaming Gorge recreation area were first thought to be from the nearest metropolitan area, Salt Lake City. But an analysis showed that more than half of the total are from distant States.

And Fishing

Fishing is an interesting sport around Reclamation's Flaming Gorge Dam. Not only is fishing considerable in the reservoir, but when the gates on the dam were closed in 1962, ideal trout fishing took place in the sparkling tailwaters below the dam. The stream was converted from a muddy waterway to a clear, cold relatively stable river. The spectacular stream winds for 30 miles through picturesque forest lands, or isolated recreation areas in Daggett County, before entering Colorado and Dinosaur National Monument.

Last December a fish specialist said the Daggett County reach of the Green River deserves to be called "Utah's Blue Ribbon trout stream." And because trout growth and aquatic food production have continued to increase here, it would likely continue to have a favorable future for trout ranging up to around 6 pounds for 5-year olds.

Further along the route of Powell's voyage, a huge, beautiful reservoir was named, a few years ago, for the intrepid explorer. At this reservoir, Lake Powell, the administering agency, National Park Service, reports a 1968 jump of about 50 percent more visitors than the previous year. The 1968 total was 883,400 at this isolated lake backed up by Reclamation's Glen Canyon Dam. And because there are no nearby cities, more of these people drove from such distant points as Los Angeles, Phoenix, Denver, and Salt Lake City.

The superb scenery at Lake Powell is unsurpassed for variety. Facilities for all kinds of water-based recreation, including fishing, are in operation year-round. Particularly excellent this year is trout fishing just below the dam, rivaling that downstream from Flaming Gorge.

Lake Mead Visitors

Chalking up the highest visitor figures of all Colorado River Basin reservoirs is Lake Mead, located near Las Vegas on U.S. Highway 95. Last year 4 million sun-seekers, fishermen and boaters showed up at this lake behind Reclamation's Hoover Dam.

Lake Mead also is associated with Major Powell because it was at the mouth of the Virgin River (now an arm of Lake Mead) that Powell terminated his 1869 voyage.

When Lake Mead is high, water backs into the gorge to Separation Canyon, where three men of the voyage climbed out of the canyon rather than face what they believed would be certain death in other violent rapids below. These three, the two Howland brothers and William Dunn, unfortunately were killed by Shivwits Indians after reaching the canyon rim.

Powell and his crew were exceptionally daring to do what they did. To explore this awesome river area had been considered an impossible feat before they undertook it, and indeed the task turned out to be almost unendurable.

Even when undertaken today—whether for sport thrills or further study—boating the Green and Colorado Rivers still is an ominous challenge. And because of the need for proper knowledge and equipment, it is accomplished by only a few.

For Powell, it was an endeavor of scientific worth. And for him it would be a service, making possible a contribution of solutions to national problems, which few other men understood or tried to measure.

Continuing his hard pioneering work, and tackling tremendous obstacles he strongly spurred on the reclamation era for the Nation. So that today, Reclamation specialists with added knowledge have been able to forge ahead with construcing dams and related water facilities in many Western areas.

Gains Totaled

The 67-year old Federal Reclamation program has brought irrigation service to 10 million acres of land in the West, 8 million acres of which were irrigated in 1967. Total gross value of crops produced by farmers on these lands is $27 billion.

Also, 600 billion kilowatthours of hydropower have been generated. Since 1950, $674 million in property damage, plus unnumbered people's lives, have been saved by structures controlling flooding rivers.

Guards against water pollution, enhancement of fish and wildlife areas, and preserving the scenic environment also are Reclamation project benefits.

Major Powell envisioned such assets as those. However, the water resource development which would amaze Explorer Powell most has come about in just the last few years—the outdoor recreation boom, and the tricks devised by fun-seekers for thrills at lakes and reservoirs.

For its part, Reclamation has constructed over 200 lakes which accommodate such activity, and serve many other useful purposes. # # #

It will be 7½ miles before this kayak paddler, now at Flaming Gorge Dam, comes to the road which touches the river at Little Hole.

If there is a question on what this hilltop hut is used for, it is a radio repeater station, and the small dark platform in front was erected there many decades earlier by the cavalrymen.

Radio replaces cavalry signaling device on Rio Grande project

Not Back to Buffalo Steak?

Indians and frontier cavalrymen, adversaries of the Old West, both knew that mountain tops were the best locations for sending smoke signals. We also understand that the cavalry signalled from high peaks with the heliograph—a mirror device for flashing messages by sun reflection.

Buffalo have long since gone, of course, and more than 100 years have passed since Indian-fighting soldiers in southern New Mexico established Fort Selden. Still durably standing, however, is a sturdy iron heliograph stand, which Fort Selden soldiers erected by mounding rock and concrete.

This small, weathered monument to frontier communications is on top of bald Lookout Peak on Robledo mountain.

From his heliograph station on Lookout Peak, the Fort Selden soldier of the 1860's and 1870's could flash his military messages as far as the old Fort Bliss, 50 miles away in the El Paso upper valley.

Because Fort Selden was very near the sending station, the helio specialist could clamor back down the slopes, re-cross the Rio Grande on a hand-rope-powered ferry and soon be safely back in his adobe fortified quarters.

The remains of Fort Selden are ghostly ruins. But the nearby message center, as if rewarded for its withstanding time, has a new companion—another message sender, strong and useful, but different.

"Newcomer" Built

The "newcomer" to the overlook site was built by the Bureau of Reclamation. Like the "little old-timer" by its side, the new Reclamation message center also has a strong independent air, so to speak, but it is more sophisticated. It is a self-powered radio relay station—the first thermoelectric (heat-electric) power generator for shortwave voice radio communications to be built on a Reclamation project.

The good companionship for the "old-timer"—and for the 63-year-old Rio Grande Reclamation project—came about only in the past 3 years. It is part of the modernization of communications for the irrigation efforts of the fertile lands on the Rio Grande Project, New Mexico-Texas.

In 1965, there was growing concern about the roject's rising costs of irrigation operations. A ommittee of Reclamation specialists studied the vater operations program.

Because of the mountain barrier in a 90-mile ong northern section of the project which separates portions of the irrigated lands, a radio relay tation was going to be required on the mountain o provide adequate coverage of information on apid irrigation events over the area. Lookout nountain was suitable too, because it is accessible y vehicle. Thanks to electronic ingenuity, the ite would not need the usual close source of electric ower.

On Indian Uprisings

On that remote mountain, the reconnaissance roup "rediscovered" the remains of the cavalry's ld signalling device. Research into historical files onfirmed Reclamation engineers' thinking that ong ago the small metal table was used to flash ommunications to old Fort Bliss about Indian prisings.

As a result of the committee's efforts, the radio elay station on Lookout Peak is controlled by the as Cruces Dispatching office, one of the two new vater communications offices on the project. That ffice serves the narrow, 90-mile long, northern irigated area from Caballo Dam to the El Paso pper valley.

The modern mountain-top message center is proided with power from its own heat type generator. This device, which has no moving parts, generates lectricity with a gas flame. It produces a low level oltage which is converted to useable power source, dequate for the relay station's radio receiving and e-transmitting equipment.

Two ordinary automotive type batteries proide the basic radio power source of about 15 volts.

The thermogenerator, powered by propone gas, eeps the batteries charged. Fuel tanks of propane, auled by truck, are replaced at 3-month intervals. Since installation, the remote radio system has iven excellent service.

The radio equipment is sheltered from wind and nclement weather in a circular metal shed, or hut, f a size which could enclose about 6 standing men. The thermoelectric generator and propane tanks re on the outside of the hut.

An alarm which is triggered by any cooling of he generator's chimney, such as if the flame should ccidentally be put out, was recently added to further upgrade the reliability of the operation. This alarm is a "beeper" signal tuned for alerting the dispatching office.

The dispatching offices are available by telephone to water users for ordering water 24 hours a day, 7 days a week, during the irrigation season. Between each dispatching office and its ditchriders, radio contact provides the means for quick and efficient completion of the water-delivery process.

Efficient Saving

Under the new system, water ordering, scheduling, delivery and recording proceeds in prompt and efficient fashion with considerable saving of time and personnel.

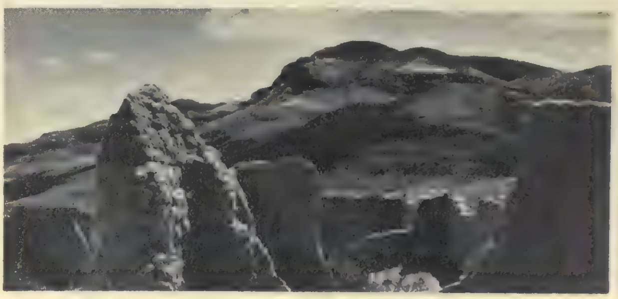
The dispatching offices maintain close and immediate control of all facets of water operations at all times. Quickly after radio-directed water deliveries are made, although they may be many miles away, they are reported and recorded promptly. The record is confirmed with the water user by post card.

Best of all, the system enables each ditchrider to control and service a larger area, resulting in another substantial savings in labor costs.

The radio dispatching system for the 178,000-acre project also has greatly improved the project's water distribution efficiency. The time lag between request and delivery has been significantly reduced, and project operators are able to respond much more rapidly to maintenance needs and occasional emergencies.

If Indians and white fighting men should return to their former signaling summit on this Rio Grande development, what might they say?— "Well folks, we reckon your shiney hut might be alright, but for smoke-curin' buffalo steak a plain wood fire in there would be powerful better'n all them new gadgets." # # #

Ghostly ruins of Ft. Selden is in foreground; Lookout Peak is in the distance; and the people who operate the Rio Grande irrigation project in this vicinity now have instant radio help.



Blue Ribbon Trout Fishing Below Yellowtail Dam

Predictions Come True

In a project report in 1962, sport fish specialists predicted that a valuable cold-water fishery would develop in the Bighorn River below the authorized Yellowtail Dam in southwestern Montana. Especially good would be the 15 miles below the afterbay.

The dam, constructed by the Bureau of Reclamation, was completed and the reservoir filled in 1965.

Spectacular fishing for brown and rainbow trout up to 8 pounds, and for sauger and walleye, is now a reality for thousands of Montanans and many nonresident vacationers.

Yellowtail Reservoir and the afterbay are also providing good fishing as predicted, but the 15-mile section of the Bighorn River to St. Xavier, Mont., is outstanding.

Pre-project fishery days on the river consisted of many species of warm-water fishes including channel and flathead catfish, walleye, sauger, burbot, sturgeon, goldeye, carp, and suckers. Trout were rarely taken in the Bighorn River, although they were present in several tributaries. Use of this fish area was quite limited.

"Blue Ribbon"

The combination of improved flow regimens, cooler water, and reduced sediment with Yellowtail Dam has changed the third class, lightly used, warm-water fishery to an excellent trout stream now attracting large numbers of anglers. It is likely that Montana's Stream Fishery Classification Map, when revised, will show this reach as Class 1, "blue ribbon." With an average flow of about 3,000 second-feet of clear, cold water released downstream, anglers should continue to enjoy quality fishing for big fighting trout.

Deciding his string of rainbows is enough for a day, Ray Chavez of Hardin, Mont., prepares to leave the Yellowtail Dam afterbay.

This visitors center provides a breathtaking view of nearby Yellowtail Dam and the ribbon-like Bighorn River 500 feet below.

In spite of the relatively high degree of success, the Yellowtail story could be even brighter. For example, uncertainty concerning public access and the lack of adequate trout spawning habitat in the downstream reaches detract from the potential fishery values. Although physical access is good, the river flows through the Crow Indian Reservation and there is uncertainty as to whether a special Tribal fishing permit may be required of all non-Tribal fishermen or whether other controls may be exercised. Until this issue is resolved, the Montana Fish and Game Department has withheld plans to develop much needed access sites.

At one time, plans included an artificial trout spawning channel downstream from the afterbay dam. However, the channel was not included due to excessive construction bids. As a result, a greater amount of stocking will be needed to perpetuate the fishing success that is rapidly becoming the Yellowtail trademark.

Is Success Story

In spite of these shortcomings, Yellowtail is a success story. The obvious reason is the fighting trout that brighten the lives of countless fishermen.

However, this is merely a reflection of a more important accomplishment, a new kind of Federal-State resource planning effort that is emerging from projects such as Yellowtail. It is this vital, cooperative effort by engineers, biologists, economists, recreation planners, and others that makes the Yellowtail a success story.

The continued efforts of these planners are helping to pave the way toward future projects where other accomplishments in the Yellowtail pattern will be the expected rule.

With the multicolored walls of Bighorn Canyon and the blue waters of Yellowtail Reservoir, one has a magnificent view of Yellowtail Dam.

Inviting View

An observation window in the visitor center invites looking down over a sheer 500-foot cliff on Bighorn River emerging like a narrow blue ribbon from the toe of the dam.

Abundant scenic beauty of the area and explanations of how the dam works are emphasized by the displays at the visitor center.

Perhaps most spectacular—if the center's observation window isn't—is the elevator ride to the power house. It is a 470-foot plunge to a view of power generators and mockup of a turbine-generator complete with moveable parts.

There is parking space for 100 cars in the center parking lot. Visitors will walk a short distance from the center itself to the dam, and they can cross the dam on foot.

Sharing operation and maintenance of the center will be the Bureau of Reclamation and the National Park Service. The tour is self-guided. No guide is necessary.

Yellowtail Dam was dedicated last October 31 with officials of Interior, Reclamation, the State, and the Crow Indian Tribe present. About 1,200 people attended.

Completed in 1965, the 525-foot high dam blocked a major flood in the spring of 1967, when the greatest runoff of record swelled the Bighorn River. # # #

Disadvantaged get jobs with Salt River Project

PROJECT HIRES HARD-CORE

by GEORGE MARTIN,
Press Representative,
SRP, Phoenix, Ariz.

Supervisory staff of the Salt River Project are meeting here for a session on ways to help the hard-core unemployed be productive.

TONY is Mexican-American, born and raised in a low-cost housing area of Phoenix, Ariz. When 8 years old, he was shining shoes on skid row streets.

Until Tony got a job with the Salt River Project (SRP), last summer at age 31, that shoe-shine job was the steadiest employment he ever held.

Tony's job history is typical of the persons referred to as "hard-core unemployed" who are being hired and trained under cooperative efforts of SRP and other concerned agencies. The Salt River Project, one of the Bureau of Reclamation's earliest water developments, was the first in the Phoenix area to contract for the improvement program with the U.S. Department of Labor. The SRP subsequently hired Tony and 42 other disadvantaged Americans.

Another organization initiating cooperative sponsorship of the employment is JOBS (Job Opportunities in the Business Sector), a program of the National Alliance of Businessmen.

To date, the progress of Tony and most others emerging from the jobless category has been encouraging.

Needful Home

Tony was born into a family of eight boys and five girls who lived together in highly needful home conditions. His widowed mother's only income was from welfare, or whatever could be garnered by her sons. Tony attended almost every elementary school in the area but did not complete the eighth grade.

After quitting school, Tony fell into the common routine of taking menial jobs when and where he could find them.

Although Tony had a seemingly directionless life, he married. He and his wife had several children in a few years and things got no better. Tony's own domestic life began to follow the family-life pattern he knew as a small boy: little work, not enough food and fiber, more dependency on welfare programs.

Then in June, 1968, Tony qualified for a job with the Salt River Project under the JOBS program. He received schooling and, within a few weeks, had passed his General Educational Development test with high scores. Now he is a trades helper with the Project's meter relay division, and plans on additional schooling to improve his skills. He has also moved his family to more suitable housing and apparently for the first time in his life, Tony can see a brighter future.

Undertook Program

The SRP pledged in April, 1968, to provide permanent jobs for 43 hard-core unemployed persons under the cooperative program. This figure represented two percent of the Project's total employment at the time. In addition, the Project pledged summer jobs for 21 youths who were hard-core unemployed.

It was necessary to determine whether the Project—a rather unique organization—could legally involve itself in a program created specifically for private industry. The SRP, which is one of the Nation's oldest and most successful multi-purpose reclamation developments, actually consists of two organizations: the Salt River Project Agricultural

Improvement and Power District, a political subdivision of the State; and the Salt River Valley Water User's Association, a private corporation.

Project officials quickly decided to contract under the name of the private corporation, thus avoiding a time-consuming legal interpretation which might have concluded that the power district would not be permitted to participate in the program anyway.

B. V. (Barney) O'Steen of the Project's Personnel Department was assigned to coordinate the JOBS program. Named to assist him was Howard Bell, a man with considerable experience in the fields of sociology and human relations.

Recruited by the Phoenix Employment Opportunity Center the 43 job applicants are primarily Afro-American and Mexican-American. The jobs provided for them are entry-level positions established by contract with Local 266 of the International Brotherhood of Electrical Workers. (Although the Project has a policy of hiring from within when possible, Local 266 waived its right of bidding for the job to support the JOBS program.)

Personnel heads Barney O'Steen, right, and Howard Bell, get together on administering and carrying out details of the JOBS effort.

Necessary Jobs

"They are not just 'make-work' jobs, created for the JOBS program," O'Steen asserted, "but are jobs necessary to the Project in the performance of its functions." The different job classifications are junior clerk, building custodian, laborer, machinist's helper, trades helper, rodman, switch gear repairman, industrial garageman, warehouse checker and groundman.

Two months after pledging to provide the jobs, the Project's contract was accepted by the Department of Labor. The SRP then received $128,060 to help cover salaries and other expenses during nonproductive time.

All applicants were given physical examinations. Only one did not pass. He was offered a job requiring less physical stamina, but declined. Four of the applicants were found to need eyeglasses, and these were provided under terms of the contract. One had a high fever, and medication was provided.

And one was hospitalized for several days after it was discovered she had processed while quite ill. It was foolhardiness, but it revealed her desire for gainful employment. The job was held until she recuperated.

Trainees are paid the regular starting wage. In addition, they receive all fringe benefits accorded to new employees, such as cost-shared medical insurance, eight paid holidays annually, and a paid membership in the Project's employee recreation club, considered one of the best in the southwest.

Fringe Benefits

Project employees are eligible for paid sick leave and vacation after 6 months employment and participation in a paid pension program after 1 year's service. These benefits also will be extended to the trainees after they reach the specified point in time of service.

Counseling was provided not only on-the-job, but on personal problems as well. Subjects covered included personal debts, consumer protection, transportation, medical and social problems, and housing. New housing was found for two trainees living in substandard dwellings.

Although the program requires considerable effort for O'Steen, Bell, and others, it's paying off.

After 5 months, only five of the original group dropped out. According to O'Steen, four left for personal reasons and one simply didn't show up for work and couldn't be located to find out why.

"All were replaced by other disadvantaged persons," O'Steen said, adding, "We feel the program has become pretty well stabilized, and the prognosis for those who are still on the job is that they will succeed and be good employees." # # #

Aerial Survey Speeds Job

SKY over Grand Coulee, Wash., was clear and blue, exactly the kind of weather Bureau of Reclamation employees were looking for. They needed such a day to make aerial survey photographs before proceeding with excavating for Grand Coulee Dam's huge new Third Powerplant.

A month of bad weather had just been endured, and for several days the engineering staff had been ready to act as soon as the sun shone.

"Any word of the survey plane yet?" asked one of the men.

"Nope." The men were tense. (Construction organizations have their uneasy times.) It was Friday, and the photographic plane was still grounded in fog at the airport 100 miles away.

Just above Grand Coulee Dam, giant excavation machinery was in place waiting to start tearing away the solid rock mountainside. The new Third Powerplant would be attached to the new wing of the dam at the right abutment.

Tension eased finally when the aerial photographer's plane showed up. It would not be long now. The plane immediately started flying its special patterns. By four-thirty the photographer in the plane finished shooting and disappeared in the direction of the airport.

Like farmers and many other outdoor people, construction men often find weather to be a key factor in the cost of accomplishing their work. But they win on averages, and the photo plane was able to fly its important mission just under the scheduled deadline.

Photogrammetry Way

This survey job was done by photogrammetry—utilizing aerial photographs rather than ground survey calculations.

Ground surveying had been started at Grand Coulee, but it was far from complete for this construction job, and it would be a much more time-consuming way to finish the necessary area.

Cost of surveying the immediately-needed 1,700 acres by ground crews would have been a $250,000 price tag, as compared to $47,000 using the photogrammetric method. The net saving was $200,000.

Another $46,000 savings on topographic maps by photogrammetry raised the total savings on the Grand Coulee Third Powerplant project to $246,000.

From the photographs, several hundred thousand individual elevations were code-punched on computer cards. Other steps included plotting and using cards to electronically compute the cubic yards of material to be excavated.

These volumes—calculated with photogrammetry and computer with less than one percent error at the Third Powerplant site—were then utilized as the basis for payment to the excavation contractor.

Because of the success of this procedure, and the large savings in connection with the basis for paying the contractor, it points the way and holds much promise for use on future projects.

Moreover, completing the ground survey would have required an estimated dozen field surveyors working two more months to cover the same area, and finding both surveyors and added time would have been extremely difficult.

Also Safer

Photogrammetry also makes it possible—and safer—to survey rough terrain, too steep for even a mountain goat to travel in some of the Grand Coulee area. Once shot, photographs are invaluable. They can be used over and over with plotting machines and computers to produce information on various subjects which would take far too long to even consider finding by hand methods. More important, photographs will provide a permanent record of original ground surface, and show intermediate and final stages of excavation for computations and checking with the contractors.

The Cessna 180 and the large cameras shown here were the equipment used to make the aerial survey of the Third Powerplant area.

The photographs also aid in establishing prop-rty lines and land areas which are particularly lifficult to define because of irregular lakeshore oundaries.

They offer interesting possibilities in making sometric drawings, "artist's conception" drawings vith engineering accuracy, and overlay drawings o indicate future lakeshore outlines.

Continued improvements in cameras, film, and related devices used in the space and military rograms, many of them still classified, also hold romise for advances in aerial surveying far be-ond what is foreseen today.

This basic survey work at Grand Coulee pre-eded two excavation contracts, each in the amount of $12.5 million.

The Cofferdam

In addition to the excavation work, a temporary 216-foot cofferdam at the right end of the perma-nent structure is being built. The cofferdam pre-vents water in Franklin D. Roosevelt Lake above he dam, from pouring into the forebay construc-ion area. A road will be constructed on top of he cofferdam to provide access to the right bank of the Columbia River.

Over 24 million cubic yards of rock and common naterials will be removed. Part of this material vill be used to build up and stabilize the right lownstream bank of the river.

The stabilization will protect against the great-er fluctuations in river flow which will occur after he Third Powerplant goes into operation.

Assembly Yard

Another part of the excavation is to provide an area in which to assemble the massive genera-ors, penstocks, turbines and other industrial ma-erials which are much too large to transport from distant places in one piece. They must be assembled in this adjacent yard.

Production of power at Grand Coulee Dam started in 1941 with the 9-generator Left Power-plant. Completion of the Right Powerplant in 1951 increased the output to about 2 million kilowatts.

The plan for the Third Powerplant is to install 3.6 million kilowatts in the form of six 600,000 kilowatt generators. The forebay has been de-signed to accommodate ultimate installation of 12 such large units. This would bring the facility to 9.2 million kilowatts, the largest in the world.

Grand Coulee Dam, located 92 miles west of Spokane, Washington, has become a popular tour-ist attraction. With the dam as the principal struc-ture, the million-acre Columbia Basin project of the Bureau of Reclamation also includes extensive irrigation developments and a growing number of recreational activities. # # #

Excavation of the mountain is well underway, none of the former right abutment of Grand Coulee Dam remains, and the cofferdam is in full use in this recent photograph of the construction area.

Getting Ahead

At 5 Job Corps Centers

WORK, school, and such recreation as football, are all "games" at Job Corps Civilian Conservation Centers. Played with the type of motivation of games, or at least as exciting opportunities, the young enrollees gain health, skills and confidence.

There would be little education and progress for the former dropout youths, if the program did not satisfy the motivation requirement.

The fast-action football game underway in the photo on this page was recently played at the Marsing Center, Idaho, between youths from Marsing and the Columbia Basin Center of Washington—2 of the Bureau of Reclamation's 7 Centers.

The players all leap to win any possible advantage as soon as the ball is snapped, with the wide-end, at left, a Columbia Basin player, sprinting downfield to catch a potential pass. Marsing narrowly won over their opponents with a final score of 7 to 6.

School Phase . . .

Meanwhile in the school phase of Reclamation's Job Corps program, many young men have picked up where they left off in the classroom, and gained

the satisfaction of actually graduating from the equivalent of high school. In the certificate awarding photo, staff instructor William Walker, left, is warmly presenting the graduation certificate to proud Corpsman Michael Goldsmith. The award is evidence that Goldsmith completed the Center's school instruction and passed the General Education Development test qualifying him for college entrance.

Work . . .

When man and mother-earth team up for planting seedlings, another kind of feat is in the making—a more beautiful landscape. Large-scale accomplishment of landscaping by Corpsmen of the Toyon Center, Calif., shown in the photographs, took place in March 1968 at a memorial park. The park, together with a hydro powerplant, was named for the late Judge Francis J. Carr, and is located at the scenic reservoir near Whiskeytown Dam.

In addition to the experience benefit of aiding shrubs to root, the young Toyon men's beautification role included transplanting trees and constructing attractive visitor facilities.

Among Reclamation's 7 Job Corps Centers, effort is underway to regularly publish Job Corps newspapers. The January edition of the newspaper, "Job Corps Express," at the Casper Center, Wyo., carried an account of the fellows' participation on a TV program entitled, "Profile of a Corpsman."

Corpsmen Appear on TV

"On Monday, January 13 four Casper corpsmen will appear on a panel discussion on Channel 8. They will discuss questions relating to the Job Corps and their attitudes.

"The program, titled 'Profile of a Corpsman,' is the first in a series planned by the Community Council. Mrs. Barbara Bannister is the chairman of the committee organizing the TV shows. Presently, Mrs. Bannister plans to telecast a program about the Job Corps once a month.

"The four corpsmen who will be guests on the show are Alfred Anderson, Thomas Gadbois, Gilbert Pleasants and Manuel Rodriquez. Mrs. Bannister will represent the Community Council, while Mr. Anderson, center director, will represent the Job Corps. Chief Paul Danigan of the Casper Police and Deputy Sheriff George Borden of Natrona County will also take part in the panel discussion. Artwork by Corpsman Louis Anderson will be displayed."

Word reached the Washington Reclamation office that the TV program above was well received by the people of Casper. Another "Express" news item quoted below notes the earnings per hour of 6 Corpsmen who got jobs after leaving the Casper Center:

Placement News

"Reports from screeners show that the longer a person stays in the Job Corps the higher his salary will be when he gets a job. Corpsmen who stay only a month or two cannot find good jobs when they return home.

"Following is a list of ex-corpsmen and the jobs they now have:

A. Robertson	construction	\$2.00
J. Ray	construction	1.65
C. Nielsen	Post Office	2.21
B. Rosemond	brick mason helper	2.00
C. Davenport	welder trainee	1.75
R. Watson	returned to high school	

"All of these corpsmen stayed longer than six months, except Watson who is getting more training in school."

Centers not otherwise named in this article are at Arbuckle, Okla., and Collbran, Colorado.—GJF

Cuts mint farming costs on Columbia Basin Project

A BETTER MINT STILL

Mint farm operators of the Jack Labbee farm at Othello, Washington, believe that: Machines should work, People should think.

This "people vs. machines" efficiency idea impressed observers on a recent day of visiting the Labbee peppermint farm and still at the Royal Slope operation located on the Bureau of Reclamation's Columbia Basin Project. News of the farm's potential continues to attract visitors from around the State and Oregon.

The farming experiment is so well designed and operated that it convinces one of its efficiency and harmony. Savings of thousands of dollars in capital outlay for equipment and labor costs have been affected over standard mint still operations.

During a week last September, about 40 people from Oregon came to observe the Labbee farm system.

This operation, of course, did not just happen. It is the result of the experience and ingenuity of farm manager Dick Keeney and maintenance chief Bob Teas. Originating with Dick, the idea was to reduce the number of seasonal employees needed, as well as equipment, and yet distill mint quickly from the 400 acres at Royal Slope.

The usual method would have involved purchase of seven trucks and employment of 28 men. But, under the "thinking men's" plan, only one truck was purchased, nine mint tanks were constructed, and 10 men employed. This resulted in a sizeable savings—about $500 per harvest day in labor alone.

Altogether the "streamlined" harvesting method called for obtaining a swather, a chopper, two field trailers, 9 covered mint tanks, and two shuttle vehicles. One of the shuttle vehicles is a tractor and the other is an especially built truck designed to load and carry the large covered tanks. These tanks, which carry chopped mint from the field, are loaded on the shuttle truck at two points: once at the still and again at the field boundary several miles away. Because the fields are rough and corrugated with irrigation ditches, the truck is driven only to the edge.

Special Tires

In their turn, the tractor and field trailers, which have four aircraft flotation tires, shuttle mint-filled tanks across the field to the boundary point, and bring back empty tanks on the return trip.

The Jack Labbee farm also pulls a sweeper and modified chaff wagon over the field in a gleaning operation which sweeps up the few remaining mint leaves and stems. This increases the yield by 5 to 6 pounds per acre.

During harvest time this is an around-the-clock operation, with manager and maintenance chief getting very little sleep. At the processing plant, still operator Dick Keeney, Jr., is busy keeping an eye on the steam pressure gauges, testing the oil content of condensed vapor and filling 55-gallon drums with peppermint oil.

This plant is known as a three-stall still, meaning it has the capacity to steam three tanks simultaneously.

As the tanks containing chopped mint are

Steps in this field operation include picking up the cut mint, chopping, and blowing it in the house-shaped tank, which will yield 80 pounds of oil. The farm is located near Othello, Wash. Operator of chopper-blower, Jim Christian, will soon have full tank.

brought from the field, Dick Keeney, Jr., attaches a steam hose and a cooking bonnet over the tank opening. During the next hour steam vapor will carry approximately 80 pounds of mint oil out of the tank, via a length of duct, through a condenser and separator, and finally into a 55-gallon drum.

High Value

When filled, the drum will weigh 400 pounds, and be valued at about $2,000. In a 24-hour period mint oil from this still will fill 10 drums and be worth around $20,000.

After processing, the mint residue, known as "slug," is dumped in a nearby field.

Mint farming and processing is a relatively small business, as compared to many farm enterprises. Of the half million acres presently under irrigation on the Columbia Basin Project, only 9,000 are planted in mint. Because of this limitation most of the equipment needed must be handled economically by either modifying it after purchase or constructing it according to the individual farmer's specifications. The latter was done at the Royal Slope experimental operation.

Planned to be next for modification like the Royal Slope plant is Labbee's mint farm at Othello, which processes 2,600 acres.

"To the best of my knowledge," said Dick Keeney, "this is the first operation of its kind in the field of mint processing." However, with the high interest in the novel plant, generated during the past harvest season, other such efficient mint operations could soon follow. # # #

Mint processed through this still turns out about $900 in mint oil per hour of operation. The barrel at lower left holds oil harvest.

Toni Salamone of AEC, left, holds one of several samples of concrete made at Reclamation's Denver laboratories for AEC's process of polymerizing. They have a slight sheen or tint after treatment.

Expanding uses for sensitive processes

Concrete Toughened by Infusing Plastic

Federal scientists are developing a new and much stronger family of structural materials by combining conventional concrete and plastic.

The project, which uses radiation or thermo-catalysts to combine the two materials, is sponsored by the Bureau of Reclamation, Office of Saline Water, and the U.S. Atomic Energy Commission.

Samples of these new materials, called "concrete-polymers," showed compressive strengths three-to-four times higher than ordinary concrete, according to a newly-published research report. Entitled, "Concrete-Polymer Materials," it describes the new materials as being highly resistant to abrasion, to freeze-thaw damage, and to chemical attack. Concrete-polymers are also highly impermeable to air and water.

Here's the process: Forms cast from conventional concrete are first placed in a vacuum chamber, then soaked in a liquid compound called a "monomer." These forms are exposed to a radiation source (Cobalt 60), or are heated in the presence of a catalyst. In either case, the liquid monomer permeates the concrete and hardens to form a polymer (plastic). The combined materials are designated as concrete-polymers.

Making Samples

Process development investigations are being conducted at the AEC's Brookhaven National Laboratory at Upton, Long Island, New York. Sample preparation, physical and mechanical testing, and environmental evaluations are being performed by the Bureau of Reclamation's Engineering and Research Center at Denver, Colo.

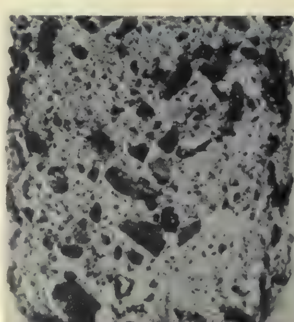
The Office of Saline Water is directing the evaluation of concrete-polymers for use in desalting plants. Particular emphasis has been placed on determining the physical and mechanical properties and the resistance of these materials to deterioration by brine and distilled water at temperatures ranging up to 290° F.

Interest in other applications of the concrete polymers has been shown by such federal agencies as the Naval Civil Engineering Laboratory, the Army Corps of Engineers, the Department of Agriculture, and the Bureau of Public Roads.

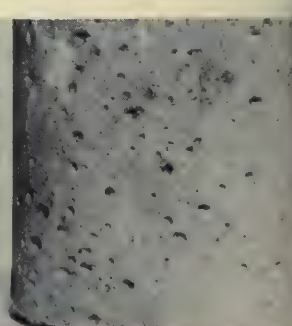
The report "Concrete-Polymer Materials, First Topical Report," No. BNL–50134, has been published by AEC's Division of Isotopes Development and the Office of Saline Water. It may be purchased for $3.00 from the Clearinghouse, U.S. Department of Commerce, Springfield, Va. 22151.

Note to Editors: For photographs and further information, inquiries should be addressed to the Atomic Energy Commission, Office of Public Information, Washington, D.C. 20545. # # #

Not impregnated.



Impregnated.



:xperts Add Info on :scaping Submerged Car

(Editor's note: In response to a safety reminder ntitled, "Leave Sunken Car Safely," in the No-ember 1968 issue of *Reclamation Era*, a Califor-ia reader helpfully submitted the comment below hich could prevent someone in a submerged car om drowning. We also are pleased to include fety steps contributed by Howard Latham, afety Officer for the Bureau of Reclamation):

ear Sir:

"I note in your November 1968 issue some com-ents for leaving a submerged automobile safely. have no idea how prevalent this problem is, but think a few additional notes are in order and at your readers should be forewarned in the ent they choose to use your suggested method of aiting until the car gets to the bottom before :iting.

"As you point out in the article, the pressure will equalized when the car gets to the bottom, how-er, the pressure which is equalized is the pres-re at the bottom of the irrigation ditch. The air e passenger breathes will be at the same pressure the water at the bottom of the irrigation ditch. , as most persons would naturally do, he takes deep breath before he opens the door and swims the surface, he will probably contract a severe r embolism, which will result in paralysis or ath. I think you owe it to your readers to point it that they must EXHALE all the way from e bottom to the top of the water."

Sincerely,

F. C. Buchter,
Departmental Counsel,
California Department of
Parks and Recreation.

est Insurance

"While drownings resulting from vehicles enter-g Bureau of Reclamation canals are not frequent currences, unfortunately they do occur. Accord-g to the record, 29 people lost their lives in this anner in Reclamation canals during the past years."

"Driving safely is obviously the best insurance ainst suddenly finding yourself in trouble in a canal full of water. If it does happen you still have a chance if you are able to keep calm and use the following escape procedures, recommended as a result of tests conducted by the American Red Cross and Indiana University:

"1. The test disclosed that a car with doors closed will usually float a few minutes. Under these conditions the best chance of escape is to roll down a window and get out immediately.

"2. A sinking car will normally nose downward with air collecting in the rear of the vehicle. Therefore, to escape, occupants should move to the rear and use a rear window. To prevent the water from rushing in it is better to wait, before attempting to open the window, until the water in the car is above the upper level of the window.

"3. Once on the bottom, with the pressure equalized, take a deep breath of the entrapped air and open a door or a window to escape. Exhale all the way to the surface to avoid air embolism.

"You will have a better chance to avoid injury and to survive the initial impact of striking the water if you are wearing your seat belt."

Howard S. Latham.

BOOKSHELF for water users

The Nation's Water

"The Nation's Water Resources, 1968," a report of the Federal Water Resources Council, is available. The Council was created by Congress in 1965 to study water problems of the Nation, including drought, flooding and water pollution.

Part I of the book is a summary entitled: "The Nation's Water and Related Land Resources." Part II is an introduction.

Dealing comprehensively with the role of water in the Nation and the principal problems now being experienced, the book was organized into 7 parts.

Part 6, for example, discussed 20 regions in the Nation, each in a chapter:

North Atlantic, South Atlantic-Gulf, Great Lakes, Ohio, Tennessee, Upper Mississippi, Lower Mississippi, Souris-Red-Rainy, Missouri, Arkansas-White-Red, Texas-Gulf, Rio Grande, Upper Colorado, Lower Colorado, Great Basin, Columbia-North Pacific, California, Alaska, Hawaii, and Puerto Rico.

In preparing this first national water assessment, the Council received the cooperation of many Federal and State agencies. Chairman of the Water Resources Council was Stewart L. Udall, who was Secretary of the Interior until last January. Members are the Secretaries of Agriculture, the Army, Health Education and Welfare, Transportation, and the Chairman of the Federal Power Commisison.

Copies are available, 472 pages, at $4.25, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The Summary Report (part 1 only, 32 pages) costs 65 cents.

Skywater Volumes

A 2-volume report of the Bureau of Reclamation's Atmospheric Water Resources Program has been printed, entitled: "Project Skywater 1967 Annual Report," the volume became available in 1968.

Volume I, with 78 pages, summarizes the development of project skywater, its activities and accomplishments in weather modification during fiscal year 1967, and the program for the future. An attempt was made to keep technical information to a minimum.

Volume II, subtitled: "Contractor Reports," contains the annual reports from the individual contractors, other details of the program, and references to technical papers. Only briefly mentioned are details of the previous 5 years of the program. It contains about 5 times as many pages as Volume I.

The volumes are available from the Office of the Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colo. 80225; and from the Bureau of Reclamation, Washington, D.C. 20240.

Engineering Research

Also made available in the latter part of 1968 was the annual report of "Progress of Engineering Research, 1967," a water resources technical publication.

The illustrated publication describes some 230 of the Bureau of Reclamation's laboratory and field research programs and their status for 1967. It is 195 pages long and includes three appendices: one on technical information retrieval and dissemination, another on the electronic computer in Reclamation research, and a final appendix on references.

Science Adviser's Report

The Science Adviser to the President recently released a report of the Federal Council for Science and Technology, entitled: "Federal Water Resources Research Program for Fiscal Year 1969." The booklet was prepared by the Council's Committee on Water Resources Research.

Discussed is the growing importance of research in a number of areas including reduction of water consumption of municipalities and industries, planning of metropolitan area water systems, analysis of water use data and control of thermal effects.

It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at 35 cents each.

**Bureau of Reclamation
Water Headquarters Offices**

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

SUBSCRIPTIONS TO "ERA" ARE ONLY $1.50 PER YEAR AT GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402.

U. S. GOVERNMENT PRINTING OFFICE : 1969 O - 335-305

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
C-6688	Missouri River Basin, Iowa.	Jan. 2	Construction of stage 04 additions to Denison substation.	Ets-Hokin Corp., San Francisco, Calif.	$388,302
C-6690	Colorado River Storage, Colo.	Jan. 13	Completion of Morrow Point powerplant, construction of visitors facilities and switchyard, and stage 02 additi ns to Curecanti substation.	Gunther and Shirley Co., Sherman Oaks, Calif.	2,869,414
S-6698	Southern Nevada Water, Nev.	Jan. 14	Eight motor-driven pumping units for pumping plants Nos. 3 and 6.	Hitachi New York, Ltd., San Francisco, Calif.	141,684
C-6699	Parker-Davis, Calif.	Jan. 22	Construction of stage 02 additions to Parker 161-kv switchyard.	Wasatch Electric Co., Salt Lake City, Utah	193,000
C-6700	Central Utah, Utah	Jan. 31	Construction of Bottle Hollow north and south dams and dike.	W. W. Clyde & Co. Springville, Utah	674,801
C-6701	Central Valley, Calif.	Jan. 10	Construction of 39.9 miles of pipelines for Westlands Water District distribution system, laterals 27 and 28.	Granite Construction Co., Watsonville, Calif.	6,828,229
C-6703	do	Jan. 16	Construction of 15 miles of concrete lined San Luis drain and 12 miles of unlined drain ditches.	Carl W. Olson & Sons Co., San Mateo, Calif.	2,681,415
C-6707	Southern Nevada Water, Nev.	Feb. 18	Construction of pumping plant No. 2A, forebay tank No. 2, switchyard No. 2, and access road.	S. S. Mullen, Inc., Seattle, Wash.	2,243,077
C-6708	Parker-Davis, Calif.	Mar. 6	Construction of stage 02 additions to Blythe substation.	Bechtel Corp., Vernon,, Calif.	469,682
S-6709	Columbia Basin, Wash.	Mar. 7	Fifteen 230-kv power circuit breakers for switchyard, Grand Coulee third powerplant.	I-T-E Imperial Corp., Power Circuit Breaker Div., Los Angeles, Calif.	1,192,610
C-6712	Missouri River Basin, N. and S. Dak.	Feb. 20	Construction of 130 miles of Valley City-Forman-Summit 115-kv transmission line.	Belgrade Enterprises, Inc., Billings, Mont.	1,740,299
S-6714	Central Valley, Calif.	Mar. 25	Furnishing and installing one armature winding for existing generator unit 2 at Folsom powerplant.	National Electric Coil Div., McGraw-Edison Co., Columbus, Ohio	173,475
C-6715	Missouri River Basin, N. Dak.	Mar. 27	Construction of stage 04 additions to Valley City substation.	Electrical Builders, Inc. Valley City, N. Dak.	415,455
0C-1037	Columbia Basin, Wash.	Jan. 21	Construction of 5.8 miles of buried pipe drains for D16-287 and D16-309 drain systems, Block 16.	George A. Grant, Inc. Richland, Wash.	106,096
0C-1044	do	Mar. 5	Construction of 15 miles of buried pipe drains for D20 drain systems and additions to D20-131 drain systems, Block 20.	Digger Dan & Sons, Inc. and Pfaff Brothers, Inc. Moses Lake, Wash.	241,545
0C-747	Central Valley, Calif.	Mar. 12	Relocation and surfacing of 2.5 miles of Indian Hill county road.	Highland Construction Yuba City, Calif.	431,059
0C-283	Colorado River Front Work and Levee System, Nev.	Jan. 17	Construction of two training structure embankments for River Mile structures 429.0 and 431.3.	Martin L. Colvin Glendale, Ariz.	231,063
0C-279	San Juan Chama, N.Mex.	Mar. 20	Excavation of 2.6 miles for Willow Creek channelization and construction of 5.5 miles of gravel surfaced O&M and access roads.	Co-Con, Inc. Albuquerque, N.Mex.	496,841
1C-688	Missouri River Basin, Nebr.	Jan. 8	Fabrication and installation of steel jacks for erosion control along Frenchman Creek, fifth section.	Capital Bridge Co. Lincoln, Nebr.	213,568

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

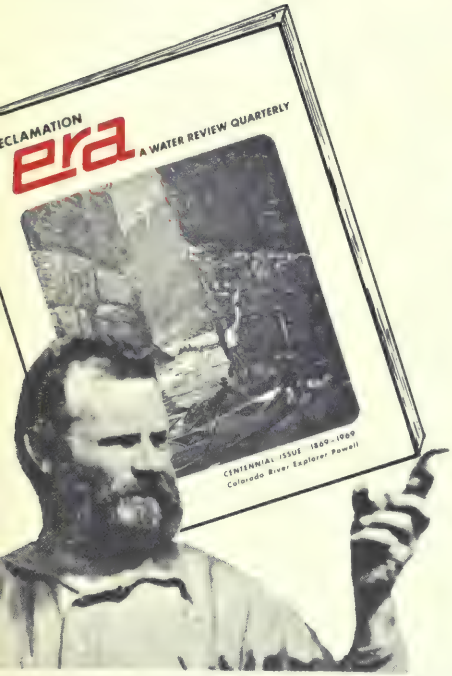
U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.



Still Available

Centennial 1869–1969 issue of Reclamation Era about

Major John Wesley Powel

THE MAN ❦ THE EXPLORER ❦ THE WATER STATESM

Read about the exploits and brillant career of one of the great men of science of the 19th Century. Learn about the big national Centennial of the one-armed Powell's exploration of the Colorado River, and the role he played in developing the natural resources of the West.

Souvenir Booklet in Color—Order Now—24 pages, more than 25 photographs in the special color issue of this Bureau of Reclamation Magazine

ONLY
45¢ eac

USE ORDER FORM BELOW

IL ORDER FORM TO:

FOR USE OF SUPT. DOCS.

rintendent of Documents, Government Printing Office, Washington, D.C. 20402.

sed find $............ (check, money order, or Supt. of Documents coupons). Please send me ....
s of the Powell Centennial issue of Reclamation Era, 45 cents per copy. (Vol. 55, No. 1)

....

address ....

nd State .... ZIP Code ....

FOR PROMPT SHIPMENT, PLEASE PRINT OR TYPE ADDRESS ON LABEL BELOW

OVERNMENT PRINTING OFFICE
ION OF PUBLIC DOCUMENTS
ASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFI

Name ....

Street address ....

August 1969

RECLAMATION era

A WATER REVIEW QUARTERLY

August 1969 Vol. 55, No. 3

RECLAMATION era

Gordon J. Forsyth, Editor

Contents

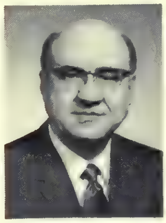
COVER PHOTO. Cutting and loading second irrigated alfalfa crop near Scottsbluff. See Nebraska article on page 28.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Floyd E. Dominy Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, January 31, 1966.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).



GREAT POTENTIAL

It is an honor for me to become associated with the Federal Department having responsibility for administration of the great bulk of our publicly owned natural resources. The responsibilities of the Assistant Secretary for Water and Power Development provide a very special challenge because water is the catalyst which makes our other resources meaningful.

Throughout its 67-year history of water resources development, the Bureau of Reclamation has become a highly respected working tool to help develop and expand the economy of the West and the Nation. Land areas that were once dry and hostile are now green, hospitable and productive, supporting the fastest growing population centers in America.

I am firmly convinced that the capital investments put into Bureau of Reclamation projects by our Government are essential to its future. In the next 30 years—until the turn of the century—the challenges to be met include an estimated population increase from 200 to 300 million people, doubled food demands, an industrial establishment four times greater and vastly increased requirements for recreation by Americans. The need for water and the need for wise management and development of our water will become increasingly critical.

Reclamationists must be innovative and creative. If we are to meet the needs of the long-range future we must begin now with a bold "Reclamation for the Seventies" program. Reclamation's program in the next decade must contain two elements, (1) to get on with authorized projects as rapidly as this Nation's fiscal circumstances permit and (2) to develop a creative and carefully coordinated program for the future.

Only thus will Reclamation meet its high responsibilities to the Nation and to the future.

James R. Smith

JAMES R. SMITH
Assistant Secretary
Water and Power Development

IRRIGATING BY "SHOWER MACHINE"

More efficient use of water is the general theme in the three sprinkler irrigation articles in this issue. Each of the articles makes a point to illustrate with productive sprinkler examples. Noted only on this page, however, is the giant "shower machine" on the Seedskadee Development Farm, Wyo.

Authors of the three articles and highlights are:

MR. LANGLEY

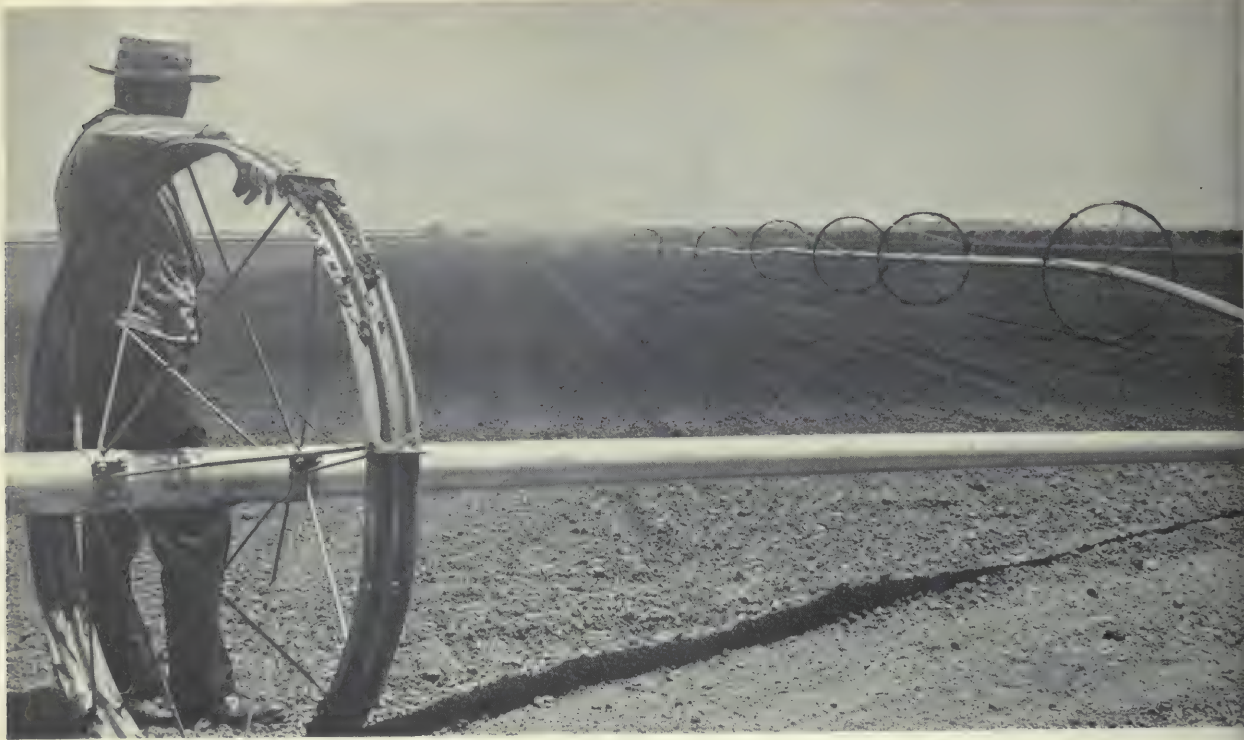
The Nation's irrigated acreage rose 26 percent in a decade, while sprinkler acreage jumped 130 percent—why the trend?—converting gravity designed land to sprinkler—comparing costs. Page 3.

MR. MARCOTTE

Farming has progressed in his area of California-Oregon—89 percent of land is under sprinkler in one district—cost of sprinklers and how they relate to protecting crops from frost—utilizing a June 29 frost. Page 18.

MR. PAIR

Main types of sprinklers—water caught in cans for evenness test—accounts for wind—rates five systems for uniformity—six requirements for selecting sprinklers. Page 24.



Above. This grower watches his newly planted field get first sprinkler irrigation on Reclamation's Central Valley Project, Calif.

Below. Cabbages watered by sprinkler, Bear River Project, Utah.

TRENDS TO SPRINKLER IRRIGATION

by MAURICE N. LANGLEY, Chief, Division of Water and Land Operations, Washington, D.C.

IRRIGATION in the United States—especially sprinkler irrigation—has been expanding rapidly.

During the 10-year period, 1958 through 1967, the Nation's total irrigated acreage climbed from about 36 million acres to more than 45 million acres, or 26 percent. Of this growth, about 3.2 million acres were irrigated by sprinkler in 1958 and a significant 7.6 million in 1967. This was a jump of over 4 million acres, or 130 percent in that decade.

This rapid rise of using sprinklers to irrigate is shared by all regions of the Nation. Nearly a third, 1.3 million acres, occurred in the Pacific region. Here the sprinkler acreage leaped from about 925,000 acres in 1958 to more than 2.2 million acres in 1967. Major growth also showed in the Mountain, West South Central, West North Central, and South Atlantic regions.

Even more dramatic than the national average is the growth of sprinkler irrigation on the Columbia Basin Project, Wash. A 230-percent jump was realized there. Almost 55,000 acres were under sprinkler in 1958, but the total was almost 180,000 in 1967—greater by 125,000 acres. Meanwhile the total of all irrigated acreage on the Columbia Basin Project increased from 238,000 acres to 453,000 acres.

This project's water distribution system was designed for gravity irrigation, and most of the farms were initially irrigated by gravity flow. So this turn to sprinkling represents a major transition.

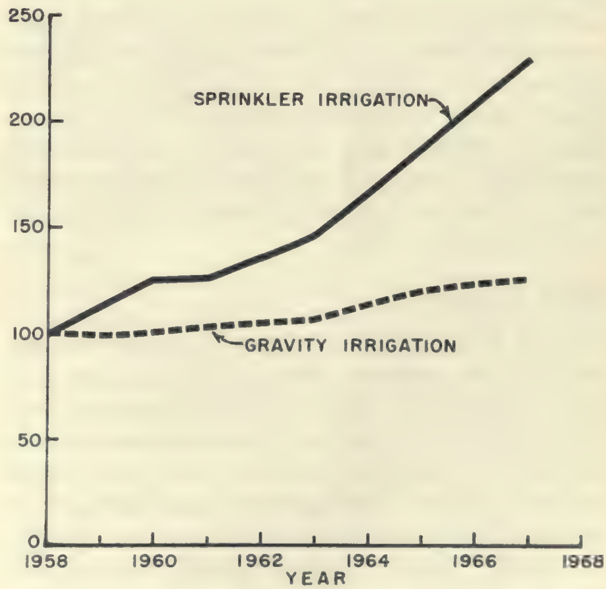
Substituting for Labor

Economic and physical factors have caused the trend toward sprinkler irrigation. Foremost is the opportunity to substitute electrical power and capital investment which can be amortized (gradually gets less) for labor. Hired labor is becoming more costly and less readily available. For example, the capital cost of a self-propelled sprinkler irrigation system is approximately the same as the cost of leveling land and developing a farm for gravity irrigation. Also, the cost of maintaining the two systems is about the same.

Therefore, the major point for the water user is whether the best economy is between the cost of power to provide sprinkler pressure for a unit of water, or the cost if irrigation labor to apply an equal unit of water by gravity irrigation.

Because labor costs have risen and electrical power rates have declined, it has become more and more feasible for the farmer to substitute electrical power for farm labor and convert to sprinkler irrigation.

With sprinkler, the farmer can irrigate shallow topsoils, without disturbing the topsoil by land



Index of growth of gravity and sprinkler irrigation 1958–67.

A King-Tuck Irrigator sucks water from the ditch to sprinkle a 360-foot wide strip of sugar beets on the Central Valley Project.

leveling. He also can sprinkle sloping lands, without problems of excessive runoff and soil erosion. And he can sprinkler-irrigate sandy lands, without excessive deep percolation and related fertilizer leaching.

As a result of these advantages, lands which would have been considered nonirrigable for gravity irrigation are frequently adaptable to sprinkler systems. This convertibility permits a consolidation of individual farming operations and of project distribution systems to most effectively serve a given acreage.

On the Garrison Diversion Unit in North Dakota, the Bureau of Reclamation is studying comparative costs between an open canal and lateral distribution system for gravity irrigation and a closed pipe pressurized system for sprinkler irrigation on approximately a 20,000-acre service area.

Preliminary indications are that a closed pipe system designed for sprinkler irrigation can be constructed within the cost range of an open canal gravity system as originally planned for that area. This is possible partly because a dominantly closed pipe system for sprinkler irrigation means that a much more compact area of land can be served for a like acreage.

Other Economies

Other factors are that laterals do not have to take the long contour route, turnouts can be centrally located on farms, rights-of-way requirements are reduced and many other economics can be achieved. Without showing details of canal capacities, size of pumping plants, and similar statistics, the greater economies of a dominantly closed pipe sprinkler system on the Garrison Diversion Unit are:

	Open canal gravity system	*Lined canals and pipe for sprinklers*
Irrigable area (acres)	19, 660	19, 770
Turnouts	410	156
Canals or pipelines (miles)	130	45
Pumping plants	12	6
Drains (miles)	209	120
Right-of-way (acres)	3, 706	853

Additional advantages of modern sprinkler irrigation systems over gravity irrigation include: the ability to apply a rather exact, uniform quantity of water where and when wanted;

— — less costly farm and project drainage facilities; uniform application of herbicides, fungicides, and insecticides to plants without field traffic and associated soil compaction; less leaching and runoff of such chemicals which could cause pollution of return flows; better germination of seed through the use of a given quantity of water in a number of light applications;

— — a reduction in the time required to get raw land into full production as compared to that required for surveying, staking, leveling and building farm ditches and structures for gravity irrigation; and better control of wind erosion by more frequent irrigation of sandy lands.

Its efficiencies make the importance of sprinkler irrigation stand out when including it in the perspective of the national water supply picture: Irrigation of more than 45 million acres in the United States presently represents in excess of 80 percent of the total consumptive use of withdrawn waters.

By the year 2020, irrigation is expected to be double what it was in 1960, and it will remain the Nation's prime user of water. # # #

Where they enjoy FISHING, HUNTING AND LIVING

by DON MILLER of the Wyoming Game and Fish Commission

MANY counties have taken their names from a river. Probably one of the more fortunate counties in borrowing identity from a waterway is Wyoming's Platte County, a 2,086 square-mile parcel of dry and irrigated farmland, grazing land, river bottom and mountainside richly underlain with historic and mineral veins.

The name "Platte" alone is not that exciting. It comes from the French word "plate," which means "dull" or "shallow." This name was first attached to the river but the rich history of the area is anything but dull and shallow.

Platte County is home for slightly more than 7,000 persons closely observed by herds of antelope, deer and elk, and flocks of pheasant, grouse, turkey and waterfowl. Its surface is regimented into neat orderly rows by strip wheat farming and irrigation marks. It is graced by the Platte River and by two scenic reservoirs. (These are the Glendo and Guernsey formed by dams of the same names, built together with powerplants by the Bureau of Reclamation.) The county's western portions are rugged steps giving way to the Laramie Peak country.

Under its surface are deposits of iron and many gem stones, as well as artifacts from civilizations past and antiques from the early West.

History

The area that is now Platte County earlier felt the rumbling clatter of wagon wheels, the gentle tread of the mountain men as they worked westward, the thunder of the trail herds from Texas, the clank of the prospector's pick, and the groan of stage coaches on the way from Cheyenne to the gold-booming Black Hills.

The history of the county must begin, however, in the silent days of the Plains Indian where the only noise to disturb the gentle sound of the wind in the grass was an occasional war whoop or the sound of buffalo being stampeded over the bluffs at Chugwater. Indian artifacts have been found throughout the county. Early reports indicate that the area was popular with the plains tribes.

Mountain men found their way up the Platte and Laramie rivers into trapping country. But the county had been seen by very few white men before the westward movements of the mid-1800's brought thousands of emigrants through the area.

The Oregon, the Mormon, and the California trails all passed through what is now Platte County. An old military road cut from Fort Laramie across the flats to the foothills of the Laramie Range. The Bozeman Trail left the main road at Horseshoe Creek and turned north toward Montana.

Rougher portions of the county are pitted with excavations of early prospectors. Moss agate stone from a deposit in the Guernsey-Hartville region was shipped to Germany in the late 1800's and is believed to be the first commercially developed deposit of moss agate in the United States. Copper deposits led to the establishment of Hartville in the 1800's but the copper supply failed to develop. The area is now the site of an extensive iron mine and Hartville, which claims to be the oldest town in the State, lives on.

Good wild turkey habitat is found in most drainages in Glendo and Guernsey reservoir areas and in western parts of the county.
(Photo by E. F. Putnam)

Game

Early accounts of hunting by military men and the multitudes of others who used the early trails for which the county is noted indicate deer and elk hunting was found throughout the Platte and Laramie River valleys. Modern-day hunters find good mule deer and antelope hunting, with limited elk hunting in the westernmost portion of the county. The bird hunters bag includes waterfowl, turkey, and pheasant.

A survey conducted in 1967 showed that nearly 2,000 deer hunters spent about 4,600 days hunting in Platte County. A University of Wyoming survey conducted in 1965 estimated that hunting and fishing contributed $532,600 to the county's economy that year.

So while Platte County is not among the best known of Wyoming's hunting areas, the pursuit of game plays an important part in the life of the county. During the 1968 hunting season, portions of the county were included in six antelope hunting areas, two deer hunting areas, and one elk hunting area.

With the growth and development of the farming industry, Platte County's pheasant and turkey hunting also increased. Today, the county offers only marginal pheasant habitat with the exception of a few limited areas in the heart of the irrigated portion of the county. During the 1968 season, however, 200 permits for wild turkeys were issued in the Laramie Peak area which includes a portion of Platte County.

The wild turkey is the aristocrat of Wyoming's game birds—the king and the trophy. Platte County turkey areas are popular hunting spots for residents throughout the region. Good turkey habitat is found in most of the drainages in Glendo and Guernsey reservoir areas, and along the western edge of the county north of Wheatland.

The Laramie Peak area became one of the first areas in Wyoming where turkeys were introduced and managed by the Commission. Turkeys were transplanted from the area into the Black Hills, now the State's largest turkey-producing area. Turkeys taken from a Platte County ranch are now living in California, following a transplanting operation.

The Platte River and its reservoirs, the Laramie River and its reservoirs, and other numerous small reservoirs provide Platte County with good waterfowl habitat areas. Each fall before freezeup Glendo Reservoir and the North Platte River become resting places for migrating geese and ducks.

Mule deer are found in the county but most of the deer kill occurs in the northern and western sections. Deer hunting in the county ranges over brushy river bottoms to rugged timber and rocky canyons. A small segment of white-tailed deer is also found in some of the agricultural regions of Platte County.

Good antelope populations are present in Platte County, with the largest pronghorn concentration being found in the southeastern and northern plains areas where rolling lands fulfill the requirements for antelope habitat.

Platte County elk are limited to small areas of the high Laramie Peak region where the western mountains meet the plains. Cottontail rabbits are found in many areas of the county.

Fish

Back in the early 1960's when folks in this area mentioned rainbow trout fishing, thoughts turned to the newly created Glendo Reservoir located in

Preserved and developed as an historic site is Register Cliff near Guernsey, Wyo. About 700 emigrant inscriptions remain legible. *(Photo by Allan Sicks)*

the northern portion of the county. The fighting rainbow were caught in large numbers. Many a frying pan in Wyoming, Colorado, and Nebraska sizzled under the watchful eye of a fisherman who had enjoyed a day on Glendo.

Fishing at the reservoir dwindled in 1964 and studies revealed that the problem was due to large numbers of stunted yellow perch competing with trout for living space.

In the fall of 1966, a $40,000 rehabilitation project was initiated by the Wyoming Game and Fish Commission to rid the reservoir of the perch and restore the rainbow. Fishery managers reported good catches in 1968 and look for Glendo to provide excellent fishing this summer.

Glendo is not the only fishin' hole in Platte County. The mountain areas in the western portion of the county provide excellent rainbow and brook trout fishing. Festo Lake near Wheatland is one of the best Wyoming largemouth bass lakes. The Game and Fish Commission has recently developed access to Rock Lake, southwest of Wheatland, which provides good rainbow fishing.

Guernsey Reservoir, the county's second largest reservoir, provides boating and camping opportunity but is limited as a fishery by the fluctuating water level.

Generally, fishing is allowed during the entire year in the county, with Rock Lake and Glendo Reservoir topping the list for the ice fisherman.

Agriculture

The county's cool summers and mild winters are advantageous for livestock growers, and the county seat town takes its name from the dry land, winter wheat farming of the area. Irrigation development in the Wheatland area has made crops of sugar beets, alfalfa, corn, beans, and small grain possible.

A white lid (ice) covers Glendo reservoir but fishermen are finding way. Geese and ducks migrate and find nesting places here. *(Photo by Allan Sicks)*

The livestock industry had its inception with the trail herds from Texas—the first domestic animals to replace the buffalo. Cattle of excellent quality are raised in the county resulting in a $6 million business from livestock production. Herefords are the predominate cattle breed with Angus and some Charolais added.

The county is favored with some outstanding registered cattle which have led to continued improvement in the quality of feeder cattle raised. The first owner-operated feeder cattle marketing association for Wyoming was organized in Platte County a few years ago. One of the annual agricultural highlights is a feeder tour conducted at five area feeding operations in January.

The irrigated area under the Wheatland Irrigation District comprises about 55,000 acres. Prin-

In scene beyond the windmill are high voltage lines and antelope shown as small specks feeding on dark areas of wheat strip farming. *(Photo by Allan Sicks)*

cipal crops include alfalfa, corn, sugar beets, beans, and small grain. Many livestock are also wintered in the irrigated area where a surplus of forage crops are grown.

In the dry land area of the county—principally the eastern third—wheat is the main crop, with some barley and oats. The area is strip farmed to preserve moisture and prevent soil erosion. About 1 million bushels of wheat fall into the hoppers of Platte County combines each year.

Herds of dairy cows are found in the Wheatland area. Milk from the area is transported to the Denver milk shed. Sheep are also raised in the county, although this industry developed much later than the cattle business.

Interestingly, while Platte County, originally a part of Laramie County, was traversed by nearly all of the early trails, not a single army outpost was ever constructed in the county. It also was one of the few parts of Wyoming untouched by the expansion of the railroads in the latter 1800's. The first train reached the southern portion of the county in 1887, but the road carried only local traffic and was never a part of the major east-west railroad systems.

Industry

The mining industry, along with the livestock industry, contributes a major portion of the economy to the county. The mining of iron ore from mines near Hartville and Sunrise is the largest mining operation. At one time this mine was one of the largest open-pit iron mines in the country. The extraction of nonmetallic minerals is important to Platte County. A rock quarry near Guernsey and numerous "rock hunter" discoveries bring many visitors to the area. Onyx, a black-spotted white stone called "zebra stone," youngite, agate, and Platte County jade are the more popular gems of the area.

Visitors, drawn by the hunting and fishing, boating, camping, and history-rich areas, also play an important part in the county's economy. State parks are located on Glendo and Guernsey reservoirs, providing facilities and activities for the entire family.

Good Place To Live

The flavor of a western, rural way of life permeates Platte County and its people. A progressive system of consolidated schools in Glendo, Guernsey, Chugwater, and Wheatland has grown from the once-numerous one-room, one-teacher rural schools. A modern, active county library is found in Wheatland—a growth from the original Wheatland Subscription Library established in the early 1900's.

Cultural and social life center around the family, the church, and the school—a way of life romanticized in western writing and still a part of living in most areas of Wyoming. # # #

(Author, Don Miller, 27, is Information Specialist for the Wyoming Game and Fish Commission at Cheyenne, Wyo. A native of that State, he rates hunting and fishing high on his list of hobbies. Don has written numerous articles for the Commission's Wyoming Wildlife *magazine, whose editor George Sura kindly permits use of this Miller article from a recent* Wildlife *issue. Don also works closely with the news media in the region and is seen and heard regularly on radio and television.)*

How the basin and Billings get payback in the pocket

Payback Monies in Missouri River Basin

by HAROLD E. ALDRICH
Regional Director

CREATING dependable water supplies and related resources conservation efforts are the principle endeavors of the Bureau of Reclamation.

When studied, such programs have shown far-reaching benefits extending throughout the Nation. However, a study made recently in the northern plains States points out how Bureau programs highly benefit a region and the Montana community of Billings.

About 90 percent of the monies to build Reclamation water control structures are reimbursable to the U.S. Treasury. This means that the people who use the water and power developed through Reclamation projects repay it to Uncle Sam—and a large part is returned with interest.

Bureau operation in the upper plains area of the Missouri River Basin is called Region 6, headquartered in Billings.

Region 6 covers that part of Montana east of the continental divide, north-central Wyoming

Left. Pouring into pit silo, this feed corn was raised on the George Baum farm on Reclamation's Huntley Irrigation Project, Mont.

Top. This downtown Billings street has the modern well kept appearance, results of good community and financial support.

352-430 O—69——2

east of the continental divide, and the States of North and South Dakota. For electric power purposes, the responsibilities of this region include parts of Iowa, Missouri, Nebraska, and Minnesota.

The financial phase of Reclamation in this region is significant. During the last fiscal year, the gross income was $48 million. That amount of money undoubtedly was helpful to the economy of a sizeable population.

Of that total, $15 million were spent in the region for operation and maintenance of structures already built. This not only included the expenses for the Bureau of Reclamation, but operation and maintenance charges for the main-stem Missouri River dams constructed by the Corps of Engineers.

$20 Million Interest

Interest on Reclamation's power investment in the region—which included all construction of transmission lines, power generating facilities, and the allocated portions of the multipurpose works—totaled $20 million.

Payments of $13 million were on the principal—which is the total investment in constructed works minus the cost for nonreimbursable flood control works and for certain parts of recreation and fish and wildlife facilities.

Someone always asks the question: "How are these dams, other structures, and developments paid for?" In brief, the criteria is that power facility costs must be repaid in 50 years with interest. Irrigation works are also partly paid for through revenues from commercial power. Irrigators pay the balance over a 50-year period, but without interest. This is the only subsidy provided for irrigation payout.

Water for municipal and industrial purposes is also repayable with interest to the U.S. Treasury over 50 years.

The overall payout is much longer for the entire Missouri River Basin Project than for any single part of the total investment. This is because all investments are not made at one time, but are extended over a long period.

People To Own Them

The end result of this huge basin construction development plan insures that investments made for various units of the basin project and the revenues from power sales are the means of paying for the project. The people of the United States are not losing, because they will own the power facility, completely paid for, including interest on the investment, and producing net revenues on the order of $40 million to $50 million annually.

In other words, the people own the facilities, and the users pay for them.

In Region 6, 28 projects or units have been constructed. The Yellowtail Unit is the latest to reach operational stage. The largest project that the region now has in the construction stage is the Garrison Diversion Unit in North Dakota.

At 21 of the projects in this region, the Bureau has constructed irrigation facilities to serve a total of about 712,500 acres of land. Our crop census for 1968 shows that from 626,800 irrigated acres, these developments produced crops worth $47.5 million at a value of $75.8 per acre. These are benefits over and beyond the Bureau's income.

The total Bureau construction costs for authorized projects in this region is an estimated $1.1 billion. Completed facilities and work in progress as of December 31, 1968, cost $555 million. During 1968 there was an increase of $20.5 million in completed works.

Contracts With Towns

Reservoirs in Region 6 serve the municipal water requirements of more than 100,000 people. Seventeen contracts are in effect with towns in areas which would have water supply problems if it were not for service from Bureau facilities.

Beef cattle for auction market in Billings are being consigned here by Martin Weinzetl who raised the 10-month old Herefords on his nearby irrigated farm. Left is chute-house man Jim Wentz.

Eight contracts are in effect in the region to supply water for industrial and miscellaneous purposes. Four contracts have been executed for industrial water from Yellowtail Reservoir, and although these uses are not underway yet, the water is producing an option revenue.

Revenues for electric power also are significant. During fiscal year 1968 power revenues were a record $44.2 million. This was an increase of $6.2 million over the previous high received in 1967. It was revenue from the sale of power to municipals at $7.1 million; private utilities at $7.8 million; rural cooperatives at $18.1 million; and other (wheeling, interproject sales, other revenues, and State agencies) at $11.2 million. Total was $44.2 million.

Supports 10,000 Montanans

In Montana, 17 Reclamation projects have been built on which more than one-third of a million acres of land has been irrigated, and they are producing about $21 million worth of crops annually. There are more than 2,500 farm families on these farms. From this productivity, about 10,000 people in Montana are supported directly, and another 17,000 to 18,000 indirectly. This results in a fair measure of stability to Montana's agricultural economy.

Huntley Reclamation Project

The Huntley Irrigation Project near Billings is a good example of how payback from a Reclamation project can cause an influx of dollars to a community.

Built by the Bureau of Reclamation in 1908, the total irrigated acreage of 24,500 acres supports 199 farm families. This means that there are about 800 members of those families circulating in the surrounding communities, including Billings, spending the income from their farm operations.

The annual value of the crops produced on the Huntley Project amounts to $1.9 million. The average annual Federal taxes paid by each of these families is $830.

The Huntley Project cost $1.8 million to develop. To date, the farmers on the project have repaid to the U.S. Government $1.4 million of this cost, and the balance is being repaid in accordance to terms of their contract.

Employees at Billings

It also is noteworthy that the Reclamation employees who direct and take care of the upper Missouri River Basin program from the Billings headquarters do something for that city.

At present there are 162 employees in the Billings office who supervise, advise, and provide assistance to other basin field offices. Most of these are trained professional personnel such as civil, electrical, hydrological, and general engineers. There are natural resources specialists, economists, realty men, soil scientists, public utility specialists, computer specialists, accountants, property specialists, procurement specialists, and staff helpers.

The payroll to Bureau families living in Billings is $1.8 million per year. Seventy-five percent of the employees own their own homes, and these are valued at over $2½ million. The annual property tax they pay on these homes comes to over $50,000. All the employees pay annual income taxes to the State of $57,000, and to the Federal Government, $307,000.

Reclamation employees average about three children per family, and many of these have already completed or are now in the educational system of Montana.

Many of the babies from the early 1940's, when the office was first established at Billings, are now lawyers, doctors, engineers, school teachers, or journalists who have remained in Montana to help build for the future.

The employees have been active in the social and civic groups which are a part of a well-balanced community. And they are in elective positions of the organizations that are an important part of the cultural life of Billings.

Local banking and business also receives benefit, for example, from the $48 million gross income for the region in the sale of water and power. More than $40 million of this income was deposited temporarily in local Billings banks on its way to the Treasury in Washington, D.C. These banks are reimbursed for this service by maintenance of a minimum balance. In one case a bank now has been authorized by the Treasury Department to maintain a minimum balance of $165,000.

The present income in this region in excess of $48 million is more than double the revenues received in 1964. This happened regardless of the fact that at the same time this increase was occurring, a reduction of over 35 percent of the employees took place.

These are some ways communities benefit from Reclamation, and are the reasons water development efforts in American move forward. # # #

Steady stream of benefits from water-use projects

Reclamation Spurs Economic Opportunity

by ALDON D. NIELSEN, Chief, Economics and Statistics Branch, Washington, D.C.

RECLAMATION'S water developments are often, at first, not close to thriving communities. But such essential community resources as water supplies, power, and opportunities for people are the results of Reclamation projects.

The vital water projects transform rich land areas of the West from "worthless," as some have termed them, to "blossoming."

Included in the multiple opportunities that new water projects bring is the extension of transportation.

Beginning with construction, the water project requires freighting of large and small quantities of materials and equipment from industrial firms, near and far, by train, truck, ship, and plane.

In the construction of Glen Canyon Dam and Powerplant, located in the canyon area of northern Arizona, for example, $10.4 million worth of business was done with the transportation industry. This amounted to 4.3 cents of each construction dollar, and hauling the required equipment and materials benefited nearly every State.

The economic impact of constructing Yellowtail Dam and Powerplant also was studied recently. A Reclamation water storage facility in a gorge of the Bighorn River in south central Montana, Yellowtail's total freight bill was $2.3 million, or 3.1 cents of each construction dollar.

On each of these jobs, more than half of the total materials and equipment used in construction was supplied from regions outside that in which the features were being built.

From Southwest

Building materials, equipment, and freight, utilized for the construction of the two dams, was valued at $50.8 million from the Southwest region of the United States. The Rocky Mountain region supplied $31.1 million; the Far West, $25.5 million; the Mideast, $24.6 million; the Great Lakes region, $9.1 million; the Plains States, $4.0 million; the Southeast, $3.1 mililon; and the far Northeast, $0.7 million.

Another $4.8 million was supplied by foreign countries which, of course, also required extensive transportation after the construction items arrived at our U.S. ports.

The above distribution of purchases is based upon the point of origin for shipment to the contractor at the construction site.

Other significant items were purchased within the immediate area of construction and shipped from warehouse and distribution centers. If these warehoused items were traced back to their manufactured source, it would be noted that many originated, or had been manufactured in the Eastern half of the Nation. Such moving of products which ultimately are used by the contractor at a Reclamation construction site is a considerable item.

Regular Benefits

Once construction is completed and water projects go into service they generate a steady stream of annual recurring benefits to a number of industries.

An example is in the Columbia Basin Project in Washington where Reclamation completed an economic study in 1966 in cooperation with Washington State University. The irrigated project area and an adjacent dry-farm area were studied for their economic impact.

Shipments from the irrigated project area increased more than threefold from 1950 to 1962. The principal commodities presently being shipped out of the project consists of perishable and semi-perishable crops such as potatoes, both fresh and frozen, dry onions, and melons. Freight out of the adjacent comparison area consists almost entirely of grains that are consigned to coastal points for export.

Wholesale value of inbound shipments to the irrigated Columbia Basin Project area in 1962 totaled $86.4 million. Of this, $40.3 million came from the Far West, Rocky Mountain, Southwest, and Plains regions and $46.1 million came from the Great Lakes, Southeast, Mideast, New England States, and Canada. Outbound shipments totaled $63.7 million, of which $39.8 million went to the Western regions and $23.9 million to the Eastern regions.

Inbound shipments to the comparison dry land area totaled only $12.8 million in wholesale value,

Grand Coulee Dam, Wash., is the principal feature credited for the $86.4 million worth of inbound shipments to Columbia Basin Project.

of which $6.9 million came from the West and $5.9 million came from the East. Outbound shipments from the comparison area totaled $21.5 million and were consigned entirely to the Far West and Rocky Mountain regions.

20-to-1 Ratio

A comparison of the two areas indicates that the irrigated area has provided a substantial impetus to growth in the regional transportation industry. Inbound carloads, gross freight revenues and transportation employees per 10,000 acres of cropland in the project area exceeded those of the comparison dry land area by ratios in excess of 20 to 1. Outbound shipments favored the irrigated areas by a ratio of 8 to 1.

The larger ratio of inbound shipments is due to the fact that the expanding farm and business economy in the project area is drawing investment capital to it.

The Columbia Basin Project in Washington provides an excellent example of industrial expansion as the water project grew. Approximately 6 miles of branch rail line was completed 2 years ago from the connecting point on the main line to the fertile Royal Slope area of the project. This area has about 86,800 irrigable acres for which water service is now available to 76,900 acres.

Another example in the Columbia Basin is about 55 miles of railroad being built from Mesa, across the Wahluke Slope to Mattawa. Again, this line will greatly enhance the development of the project and the economic environment of the area.

Crop Shipments

A major transportation industry function is the movement of food crops from Federal Reclamation projects and the Western States in general to consumers in other far-distant regions of the Nation. The 17 Western States as a whole, including both Federal and private irrigation development, produce about 60 percent of the Nation's supply of vegetables, fruits, and nuts and supply substantial amounts of such produce for the major eastern metropolitan markets of New York, Boston, and Philadelphia. Federal Reclamation projects alone produce about 20 percent of the Nation's supply of these crops.

About 50 percent of the total fresh fruits and vegetables for 37 major city markets in the United States are supplied by producers in the 17 Western States. In 1967 the West supplied about 31 percent of the fruits and vegetables at nine eastern cities; 45 percent at 11 southern cities; 43 percent at 11 mideastern cities; and 82 percent at six major western cities.

California alone provided about 34 percent of the total unloads at Houston, Tex., for example; 25 percent at Chicago and 20 percent at such far-distant cities as New York and Philadelphia.

In addition to the vast transportation requirements generated by agricultural production on all Federal Reclamation projects, another major transportation requirement is in moving all the equipment and supplies necessary both by the Bureau of Reclamation and the local water user organizations in the annual operation and maintenance of the water projects.

Another major development is the increased industrial expansion in the West as a result of municipal and industrial water service becoming available. Municipal and industrial water deliveries from 54 Bureau of Reclamation projects during 1967 totaled 543.2 billion gallons, to help meet the requirements of 13.7 million people. This represents a tenfold increase in water deliveries since 1956 when 25 projects supplied 53.9 billion gallons for 1.1 million people. # # #

Water for 134,000 people measured "by the teacup"

Handling Water by COMPUTER

**by ROD J. McMULLIN, General Manager
Salt River Project, Arizona**

THE newest and oldest ways of bringing vital water from rivers to serve man's needs are seen in comparison in the Southwest. Computer operation is the new efficient way.

Nonetheless, the ancient system was noteworthy. The prehistoric people, known as Hohokam, had the know-how—in about 200 B.C.—to construct and use a 125-mile long system of canals to divert water from the Salt River, Ariz., to irrigate their corn and cotton fields.

In the 1860's the first white settlers to the valley constructed canals which followed the courses set by the prehistoric ditches in many instances. Quite often conflicts on water rights arose among the pioneer settlers—even to the extent of using firearms to protect water supplies. However, neither of these earlier peoples achieved the advantage of storing spring runoff waters and having them available to combat the withering heat of desert summers.

The situation today is far different. One of the Bureau of Reclamation's most successful multipurpose water reclamation developments, the 58-year-old Salt River Project, now utilizes six dams and storage reservoirs in the mountainous upriver basin of 13,000 square miles. As needed, these stored water supplies make crop harvesting possible on 250,000 acres of land, much of it year-round. Moreover, hydroelectric power is provided to more than 140,000 people in Maricopa, Gila, and Pinal Counties.

Also different—instead of bullets solving the individual's water-rights problems, now it is computers. Even water rules dating back to 1869 are taken into account by the machine problem-solvers to achieve equitable distribution to more than 134,000 customer accounts.

Efficient measuring amounts virtually "by the teacup" from the watershed, through a 1,200-mile system of canals and laterals to the users is the job of the computers.

Remote Data Processing

The computer complex is built around two system/360 central processing units—a model 40 and a smaller model 30—which are installed at the Salt River Project administrative headquarters in Tempe. These computers are equipped with the latest data cell and magnetic disk files. They are the heart of a teleprocessing network which includes 15 remote 1050-type communications terminals.

Located in the project's various headquarters departments and in three irrigation field offices and five branch business offices throughout the valley, the 1050s are linked directly to the computers by telephone. Employees at those points use the typewriter-like terminals to inquire through either computer for the status of any water or power account.

Connie Rae Young gets customer information answers on screen.

The teleprocessing network enables employees in the project field offices to promptly and efficiently fill orders for irrigation water.

Immediately available before filling such water orders are such essential data as the users' water rights and the current balance of his allotment of stored water.

All landowners in the Salt River Project are entitled to an equal share-per-acre of the water controlled through the project's series of six dams and reservoirs on the Salt and Verde Rivers. This averages about 3-acre-feet per year per acre of land. In addition, many landowners also have rights to water based on Normal Flow, a principle established by a 1910 Arizona court decision known as the Kent Decree.

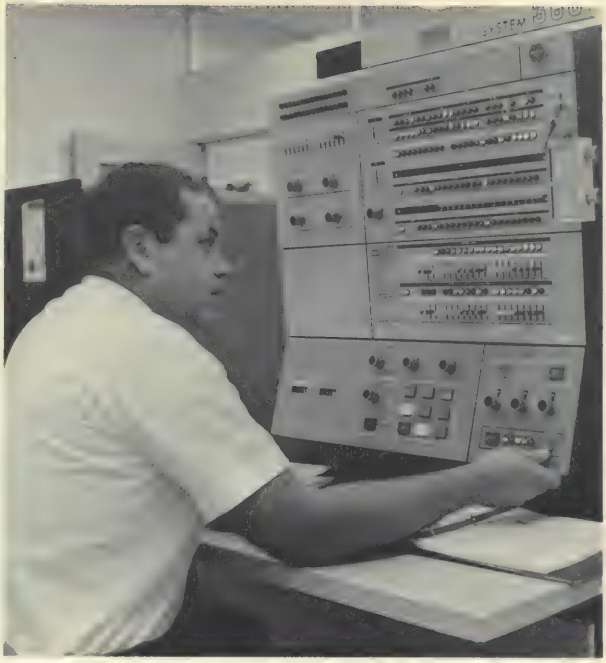
In the Normal Flow principle, owners of land which was in cultivation from 1869 to 1909 are entitled to purchase additional water, by virtue of prior use, based on the normal flow of the Salt and Verde Rivers prior to construction of the dams. These rights vary, depending on the in-cultivation age of the land. Availability of the water is based on 8-day flow cycles of the rivers compared to the average flow prior to 1909.

An additional problem for the computer is that some landowners also have prior rights to purchase underground waters, which they agreed upon because their lands were irrigated wholly or partially by water pumped from underground before being brought into the project. This water is provided by the 243 deep-irrigation wells on the project.

Central Master File

The individual water rights of each 1 acre or more of land are stored in a computer master file. This file also contains a brief legal description of the land, identifying data on the landowner and operator, and a continuously updated record of the water each account has used during the calendar year. The file also includes an accounts receivable record, including the status of the landowner's semiannual irrigation water assessment.

With such complete data available to the remote terminals, field or branch office personnel can make direct inquiry into the computer files and immediately answer water customers' inquiries regarding their delivery status, their stored and developed water balance, and the amount of normal flow or pumped water which they may be entitled



Computer complex Supervisor, Gary Brown, prepares to run a report.

to purchase.

Combining delivery orders from farm accounts each day, the water delivery men, or "zanjeros," at field offices place an overall order with the field dispatchers for the day's irrigation demands. The total water volume required is then discharged from the reservoirs into the designated canals and laterals. When the day's deliveries are made, each zanjero turns in a completed order form for each account, indicating the date of delivery, "on" and "off" time, total hours of run, and head size of the flow.

The order forms are sent each day to the data processing department where the water delivery information is keypunched onto cards and entered into the computer for updating of the account master files.

Many times, an agricultural account will request an open or "notice" irrigation run. In these instances, the order specifies the "on" time only, and the run—which may be for several days on a large farm—continues until the customer requests a shutoff.

During a notice run the computer automatically plans ahead. It calculates the volume of water that has been delivered at the end of every 24-hour period, and analyzes the account to determine if it has enough water balance to enable the run to

continue for another 24 hours. If it finds that the account is likely to exceed its water balance, the computer automatically transmits an alert message to the appropriate field dispatcher via the teleprocessing network.

Subdivision Supply

The Salt River Project also furnishes water to residence lots down to 1/5 acre, for irrigation of lawns, trees, and shrubs. Here, the water balance is maintained by the subdivision rather than by individual account; however, water deliveries to each lot are scheduled separately by the computer.

Deliveries to subdivisions are made on a cycle of every 14 days in the summer and every 28 days in the winter. Several days prior to delivery, the computer generates irrigation request sheets for the subdivisions listing each user, and a suggested water order, or flow time, which is based on the size of the lot.

Request sheets of the users are posted on boards at designated spots in the subdivision. Then users who want water on the next scheduled delivery, enter their actual orders on the form. In most instances the actual orders are identical to the suggested orders. However, unless water is unusually scarce, orders for a longer run are accepted within reasonable limits.

The completed request sheets are picked up from the subdivisions and are delivered to data processing, where exception data only is keypunched and entered into the computer. This includes any order for an amount other than the suggested order, or the account numbers of users who failed to enter an order.

After dropping out the accounts which did not order, the computer determines the next total water order and run time for the subdivision. The computer produces another set of irrigation schedule sheets. Each sheet, which is posted on the subdivision board 24 hours in advance of delivery, alerts the users as to the exact times that water will be delivered to their lots.

Every 6 months the computer uses the data stored in the master file to generate the water shareholders' assessment register. At the same time, it produces an assessment statement for each shareholder.

Using the same data, the computer also produces a monthly statement for each water user, detailing water delivery and cost information.

Statistical Reports

As a byproduct of the irrigation water accounting, a number of monthly statistical reports which are of value to project management, also are developed.

These include a report showing the total water charged to each canal and lateral during the month, broken down by type of account (farm, domestic, industrial, etc.), and a lateral report, which accounts for water deliveries to each lateral for every 24-hour period.

Another computer-generated report shows up any water loss. This helps irrigation services and engineering personnel to spot possible errors in reporting, or to pinpoint sections of canals and laterals that may need to be lined or repaired.

Following a longstanding reclamation principle, the Salt River Project uses revenues from the power it generates to support its water and irrigation operations, thereby enabling water delivery charges to be held to a minimum. At the same time, the project is able to provide inexpensive electrical service to residential, commercial, industrial, and agricultural power users in the three-county area.

A master file on the project's 140,000 power users is also maintained in the system/360's data cell storage. For each account, the file includes information on the amount of electricity used and its cost.

Monthly meter readings of electricity-use are entered into the computer on special cards which are marked by meter readers. This eliminates the step of keypunching data cards and provides the computer with the information needed for all customer billing and accounting, as well as other power studies which are made from time to time.

Expansion

Another part of the Salt River Project's computer expansion is the addition of 10 display stations to be installed in a new Customer Information Center at the Tempe headquarters. Using these TV-like visual terminals, employees will be able to respond immediately to customers' telephone inquiries. By simply keying in the account code number, any water or power file in the computer is immediately accessible and the needed data flashed on the display screen.

The advanced data processing system also has helped to improve the efficiency of project engi-

A water delivery man is turning one of the projects gate valves.

neering and planning. An example is the complete mathematical model of the project's watershed, rivers, dams, and reservoirs which has been constructed and stored in a computer file. Using a specially designed simulation program, engineers can simulate the effect that changes in humidity, precipitation, snowpack, temperature, and other factors will have on the system. Runoff conditions can be accurately forecast, based on 35 years of historical data which is also stored in computer files.

With simulation studies of this kind, specialists can accurately determine the amount of water which can be safely released from the reservoirs during any period, while assuring that the project meets its obligation to maintain full reservoir levels at all times.

With an eye toward future conservation, the Salt River Project has also put its computers to work on a number of other long-range programs that will help in the scientific management of central Arizona's most important natural resource.

One such program is planning participation in "cloud seeding," or artificial precipitation experiments. It plans to study the relationship of solar radiation to water usage, and the practicality of reclaiming water from effluent sources and using it again on the land. # # #

WHO'S IN A CO-OP?

Co-op month is scheduled for annual observance next October in most of the country. During that month, discussions and presentations will be held on what cooperative participation involves, and how such programs benefit members.

A Reclamation tie with co-op systems has been the successful operation of private water-user organizations on Reclamation water projects in the 17 Western States.

Also Bureau power operations relate to co-ops with considerable credit for unitedly increasing the use of electric power in farm areas.

Who else are co-op members?—Credit unions, of such groups there are about one-quarter million. Co-op groups operate fishing boats or vessels, group health plans, group housing projects. And co-ops operate such rural programs as marketing and purchasing, telephone service, credit loaning, and fire insurance. This is user-owned business.

Membership, in all of the many types of co-ops, is now about one-third of the population of the country.

Protects crop from summer frost

Sprinkler Irrigation Comes to Klamath Basin

by JOSEPH B. MARCOTTE, Jr.
Chief, Engineering and Construction Division
Klamath Project Office

SPRINKLER irrigation is fast encroaching on "tried and true" methods of surface irrigation in the Klamath Basin. Located in southern Oregon and northern California, one of the oldest irrigated areas on the west coast, the Klamath Basin, is experiencing a kind of revolution in such farm practices.

Agriculture in this area began with stock raising and homesteading in the 1850's and 1860's, and first irrigation diversions began in 1885. Irrigation practices expanded rapidly after the beginning of the 20th century. In 1905 the U.S. Reclamation Service, now the Bureau of Reclamation, began reclaiming and developing land for irrigation in the Upper Klamath Basin.

Of an estimated one-half million arable acres in the Klamath area, 334,000 are presently irrigated. This total includes the almost one-quarter million acres irrigated on Reclamation's Klamath Project.

During the period from 1900 until the late 1920's, there was considerable diversification of crops grown within the basin. All of the fruit and vegetables harvested at that time were mainly for local consumption. As transportation facilities gradually improved, an increasing outside market for hay, beef, and dairy products induced greater production of these items and resulted in dwindling acreages planted to orchards and row crops.

Crops Grown

At present, hay, grain, potatoes, forage crops, and cattle raising account for the largest use of the developed agricultural lands. Potatoes produced on the Klamath Project are now among the leading agricultural commodities of the region.

Soils range from a highly productive peat in the reclaimed lake beds to a sandy and clay loam in the upland areas.

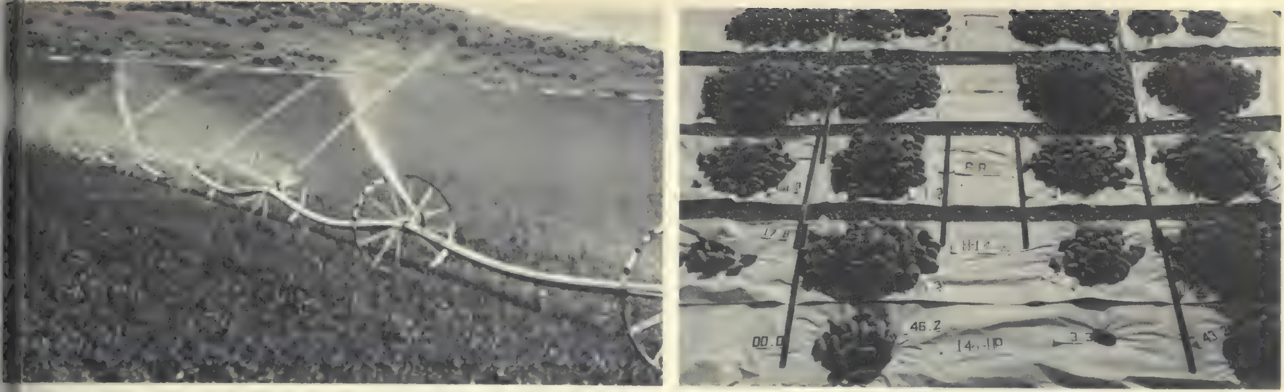
The basin's elevation is above 4,000 feet with an average growing season of 120 days. This factor means that frost damage can and frequently does occur at almost any time of the growing season.

Agriculturists are having considerable success in protecting crops from frost by sprinkler irrigation. In the Klamath Basin experience has shown that potatoes, for instance, can be frost-protected from temperatures as low as 24°.

Frost protection by sprinkler is attributed to three factors: (1) When water changes to ice, the heat released from the water raises or keeps up the area temperature; (2) A fog drift of moisture forms a blanket-like protection, or insulation, which tends to hold the ground heat; (3) When the temperature rises above the freezing point, especially when the sun melts the ice covering plant leaves and stems, the heat used in melting will be obtained from the humidity in the air and the sprinkler water being applied. If there is no moisture in the air or water being applied, the heat will be drawn from the plant covered by the ice, or frost, which will result in a breakdown of plant cells and frost damage.

Current Sprinkler Use

Sprinkler irrigation came into use in the Klamath Basin over 20 years ago, when farmers discovered that this practice would help produce quality crops on some of the marginal outlying



Left: Typical wheel-line sprinkler system operating in grain field. Right. The piles of potatoes along right side of the photograph represent a test crop which was given sprinkler protection from a frost. Their growth was more successful than the yield of smaller ones at left which had no sprinkler protection from frost. *(Photo by J. W. Kerns)*

sandy hill lands. Sprinkling remained in such use into the early 1960's when it had a phenomenal increase. For instance, solid set sprinkler systems were used to irrigate 20 acres of potatoes in the entire Klamath Basin in 1962. By 1966 nearly 4,000 acres were irrigated in this way and the trend is continuing. It has been estimated that 50 percent of the 25,000 acres of potatoes in the Klamath Basin will be under solid set systems within the next 10 years.

Annual sales of sprinkler irrigation systems have increased approximately 385 percent since 1962, and it has been estimated that over 50,000 acres of land are under sprinklers in the basin.

In one irrigation district 89 percent of the irrigable land is under sprinklers. This district is presently considering a rehabilitation program which would include a pipeline distribution system with pressures sufficient for sprinkler irrigation. One private landowner in the basin has installed a fully pressurized distribution system which serves approximately 2,000 acres producing grain, potatoes, and alfalfa.

Sprinkler irrigation in this area appears to be a matter of good economics. Farmers are finding that by using it they can operate more efficiently and produce more and better quality crops. The greatest impact is now on potatoes; however, sprinkler irrigation of other crops is definitely on the increase.

The on-farm sprinkler systems used by farmers in the basin are basically of three types: hand-move line, wheel-move line, and solid-set systems. These systems are generally made of aluminum and installed above ground. Each of these systems distributes water from a revolving sprinkler head.

Hand-move line.—This system is an arrangement of a mainline and laterals which are composed of joints of pipe from 20 to 40 feet long with quick coupling connections. The laterals are moved in 60-foot reaches to cover the entire field for each application. The system involves the least amount of equipment and therefore is the least expensive. On the negative side, however, it requires the greatest amount of labor, and offers the least protection from frost. Average initial capital costs including pumps, is $100 per acre.

Wheel-move system.—This system is composed of a mainline and laterals mounted on wheels. The laterals irrigate in approximately 60-foot forward moves. The labor involved is much less than that of the hand-move line. A certain amount of frost protection can be obtained with a wheel-move line by sprinkling at each 60-foot location. This applies a protective coat of ice and the process is repeated to melt ice from the plants. Average initial capital costs including pumps is $150 per acre.

Solid-set system.—Solid-set systems are the most expensive although new developments are reducing the cost significantly. These systems allow complete frost protection and also have the added benefit of a greatly reduced labor requirement. The systems are generally laid out from a mainline with lateral extensions spaced at every 50 feet and sprinkler heads spaced 30 feet along the laterals.

New developments involving the use of plastic, light-weight pipe offer the promise of reducing costs for solid-set systems. The average cost of an all-aluminum system including pumps is $550 per acre. However, with new developments using pipe, average costs including pumps are in the order of $350 per acre.

Advantages

Generally, the advantages of sprinkler irrigation outweigh the disadvantages. The advantages are:

1. *Increased yield and improved quality.*—A more uniform application of water brings about a more uniform development of the crops and subsequent simultaneous maturing of the crop. This results in greater crop quantity and quality both of which contribute to a higher income for the farmer. In general, sprinkler-irrigated lands in the Klamath Basin produce an average of 350 sacks (each weighing 100 lbs.) of potatoes per acre whereas lands irrigated by surface methods produce an average of 275 sacks per acre.

2. *Frost control.*—Frost not only limits the growing season, but may occur on any given day of the year. Crops are seriously set back, if not totally destroyed. Research work by experiment stations and actual experience of the farmers reveal that with properly applied sprinkler irrigation, potato crops can be completely protected down to 24°. The plants are benefited not only during the early productive stages allowing the plants to develop properly, but the growing season can be extended to allow full maturation of the plants.

It is generally accepted in the basin that an additional 500 to 700 pounds of potatoes per acre can be gained for each day the growing season is extended. Farmers are normally successful in extending the growing season 10 to 14 days, thus gaining an average 70 sacks per acre additional production.

The impact of frost protection was shown recently by county agent Walt Jendrzejewski. In this case certified seed had been planted May 25. Several alternate laterals of a solid-set sprinkler system were not in use during a damaging frost on June 29 because there was insufficient water in the ditch to operate the entire system. Killing frost, which ended the growing season, occurred September 19.

A comparative study of the sprinkler-protected and unprotected portions of the crop were made in the 82 days between the June 29 frost and September 19. Differences showed that frosted vines had 20 to 25 percent less leaf surface left after the June 29 frost.

Total yield on the sprinkler-protected area was 466.1 sacks per acre or 70.8 sacks per acre greater than that of the unprotected area. Yield of 2-inch minimum diameter No. 1 grade spuds was 394.7 sacks per acre, or 92 sacks per acre greater than that of the unprotected area. In value to the farmer, this meant that solid-set sprinkler irrigation providing frost protection, resulted in an increase of $440 more per acre.

Frost protection of grain crops is not feasible.

3. *Reduced labor requirement.*—Probably the largest single cost for any potato grower is field labor, particularly those who furrow irrigate, and good labor is becoming more scarce regardless of price. A farmer can handle more acres with less help, up to 70 percent less, depending upon the type of sprinkler system chosen.

An example of this type of savings is illustrated by the operation of a potato farmer in the Tule Lake area. This farmer produces potatoes on 500 acres of land leased from private individuals. Under surface irrigation, the operation required three 4-man irrigation crews working almost steadily from the first of June through the 15th of August. Today with 350 of the 500 acres under solid-set sprinkler systems he irrigates the larger sprinkled land with two men and the surface cropland with a three-man crew. Such a reduction in irrigation labor is important to this farmer.

4. *Improved field conditions.*—Sprinkling at the proper moisture intake rate greatly improves the condition of the soil. It causes less crusting and leaves the soil loose and friable, rather than cloddy. This substantially reduces tare on potatoes and makes them easier to dig. Some growers report they can operate their bulk harvesters with fewer sorters when digging potatoes in sprinkler-irrigated fields.

5. *Reduced water requirement.*—In some cases the savings of water amounts to as much as 50 percent, primarily because there are fewer distribution losses and the water enters the ground at the point where it is to be utilized by the plant. This eliminates an over-irrigation at the head of the row to gain sufficient moisture at the tail end of the row.

As a result of reduced water requirement, irrigation districts enjoy a benefit in the fact that the average sprinkler delivery will require a flow of approximately 2½ cubic feet per second whereas the average gravity delivery requires 10 cubic feet per second. This allows more flexibility in the operation of distribution systems.

Additionally, since a more efficient use is made of the available water, the surplus flows which show up as drainage are reduced.

Other miscellaneous benefits.—Although much of the land now being devoted to sprinkler irrigation has previously been leveled for furrow or flood irrigation, leveling is not required for successful sprinkler irrigation. Adding sprinklers to a field eliminates the need for cross-ditches for furrow or flood irrigation.

Herbicides, insecticides, and fertilizers applied directly to the lands through the sprinkler system save time and labor in that they substantially reduce cultivation. Caution should be exercised in this effort, however, since some compounds are corrosive to aluminum piping and the copper and aluminum sprinkler heads.

Disadvantages

There are some disadvantages found in sprinkler irrigation systems:

1. *High initial investment.*—However, finance organizations, including local banks, recognizing the value of sprinkler irrigation, now assist farmers to justify such installations and are quite willing to finance such ventures.

2. *Power costs.*—On systems where farmers apply their own sprinkler pressure, power costs show up as a direct expense, and, depending upon the method used—electric power being the lowest cost and gasoline engines, the highest cost—the expense can be quite significant. However, such expenses are more than offset by the increased production and protection offered, and by reduced labor costs.

3. *Distribution system maintenance.*—In order to gain frost protection it is necessary to extend the normal irrigation season further into the fall. The districts find that this presents additional maintenance costs, especially for aquatic weed control in existing ditches.

Sprinkler irrigation in the Klamath Basin is presently realizing an increasing popularity because the advantages far outweigh the disadvantages. It can readily be seen that although grain and other crops benefit from sprinkler irrigation, the greatest benefit in the basin is to potatoes.

The future for sprinkler irrigation in the Klamath Basin is good. Agricultural specialists hope that with a potential of climate control, and other benefits, new crops can be introduced on an economical basis which will encourage a more diversified agriculture in the basin.

Among the plans for increasing the sprinkler program in the basin is a proposal being studied by the Bureau of Reclamation's Klamath Project Office to construct a pressurized pipe distribution system to ultimately serve approximately 6,000 acres of reclaimed land. # # #

BOOKSHELF for water users

Report of Colorado River

The 12th annual report of Reclamation's Colorado River Storage Project and participating projects, fiscal year 1968, with 45 pages, recently was completed. The report is available from the Bureau of Reclamation regional headquarters at 112 South State Street, Salt Lake City, Utah, 84111, and other Reclamation offices in Denver, Colo. 80225, and Washington, D.C. 20240.

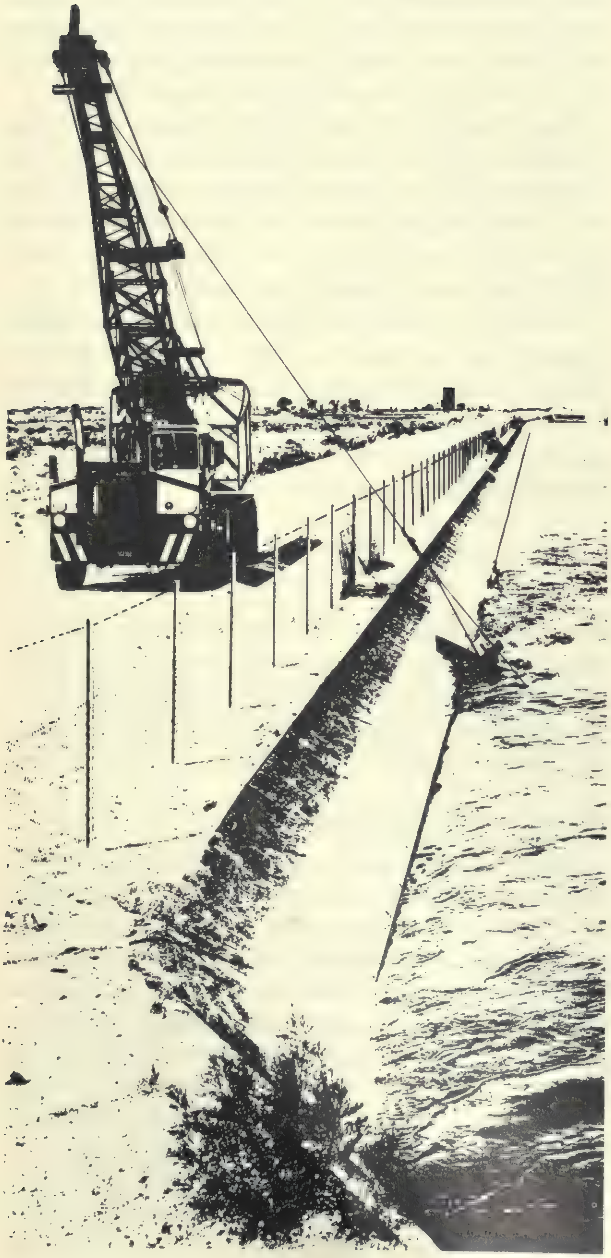
Earthquake Data Published

"Earthquake Activity in Western United States" has been issued. It contains a series of maps showing the epicenters and intensities of earthquakes in the West, including Alaska and Hawaii. The publication also discusses the scales used to measure earthquakes. Cost of the publication is not certain at this printing, but it is available at the Reclamation headquarters at the Denver Federal Center, Denver, Colo. 80225.

Water For Peace Proceedings

Notice of publications of the proceedings of the International Conference on Water for Peace, held in Washington in May 1967, has been issued by the Government Printing Office. The Proceedings is in 8 clothbound volumes and will include more than 600 technical papers submitted for the Conference, including 15 papers by members of the Bureau of Reclamation. A limited number of sets, expected still to be available are priced at $60 each, with $12 additional for foreign mailing. Orders should be sent to Sales Planning Section, Superintendent of Documents, Post Office Box 1533, Washington, D.C. 20013. # # #

Aqueduct Cleanout Speeds Water Rate



by **DANIEL J. BLACKBURN** of
Metropolitan Water District of Southern California, Los Angeles

WATER poured through the Colorado River Aqueduct at a record-setting volume following the 17½-hour-long cleanout of Whipple Mountain Tunnel and nearby conduits and canal early this year.

Speedy completion of the cleanout, which was expected to take 24 hours, was made possible by the use of two skip-loaders specially modified by district personnel. Some 40 miles of tunnels and conduits were scoured during the operation.

The converted skip-loaders may appear ludicrous to the layman; the machines, however, are the end result of more than 15 years of experimentation with gas engine-powered cleaning vehicles and proved highly successful.

Water which the Colorado River Aqueduct carries is pumped from Lake Havasu on the Colorado River. Lake Havasu is backed up by Parker Dam, which was built by the Bureau of Reclamation in 1938 with funds from the Metropolitan Water District of Southern California. The aqueduct was built by, and is operated by the MWD.

The aqueduct system's tunnels are almost pentaggonal in shape, with a concave bottom and round top.

"Spider" Cleaner

The shape of the tunnel's interior necessitated a specially designed cleaning machine. The "spider" was the answer.

Six brushes, hydraulically operated to assure a flush fit against the tunnel siding, surround the skip-loaders. The spring steel "tufts" are designed to allow scraping in either direction, as it is impossible to turn the machine once it has been lowered into a tunnel opening.

This unique equipment was the brainchild of A. E. Preston, who retired as superintendent of

Right. One of two such machines used recently to clean MWD water tunnels.

Photo on page 22. Scraper effort cleans deposits from sides of Colorado River Aqueduct. (*both photos by Al Monteverde*)

Aqueduct Maintenance in 1967 after 36 years of service with the district. His successor, William J. Meglen, now supervises the annual operation.

Open stretches of canal are cleaned by a giant "scraper" pulled along the concrete sides by a crane.

Dawn was still 2 hours away January 22 when the two specially constructed vehicles equipped with extendable 6-foot steel brushes were lowered into Whipple Mountain Tunnel and nearby conduits. Outlet gates at Copper Basin Reservoir had been closed the preceding night so that water could be drained for the cleaning effort.

A mammoth 25-ton crane placed each cleaning rig into the tunnel or conduit sections to be scrubbed.

Bigger Flow

Operating on a precise schedule, nearly 60 district personnel participated in the cleanout. After the gates at Copper Basin Reservoir had been reopened the evening of January 22, after "operation cleanout," 1,858 cubic feet of water a second (cfs) was soon on its way again—only it was more—toward southern California.

Water flows previously had not been measured above 1,763 cfs. The canal's original designed capacity was 1,605 cfs, said Colorado River Aqueduct engineer Robert E. Whaley.

The cleaning is needed because of the gradual buildup of algae and mineral deposits on the tunnel and conduit walls. The steel brushes scrape the residue from the sides of the tunnel; the sludge then gathers at the bottom and is washed down the aqueduct to be trapped and removed at one of several sand traps located along the canal.

Once the machines are settled in the tunnels, the brushes are extended flush with the sides and the operation begins.

With a deafening roar and a cloud of exhaust, the machine starts its tedious, 3-miles-per-hour trip, a return-trip run that may take—in the case of the Whipple Mountain Tunnel cleanout—as long as 4 hours. # # #

(*Author of this article, Mr. Blackburn, is a public relations representative of the MWD and associate editor of the district's* Aqueduct News. *The* News *featured his article in its February 1969 issue.*)

Eight major systems for irrigating

Tests Show Sprinkler Valves

by **CLAUDE H. PAIR,**
Research Engineer
USDA, Kimberly, Idaho

EARLY systems of sprinkler irrigation were all hand move, portable, lateral types which required a minimum of capital and considerable labor to operate. There was good reason for farmers increasingly looking to mechanization for cutting labor requirements. And the sprinkler industry has responded by introducing large numbers of mechanical-move, or mobile systems.

Essentially, buyers now have a choice of eight major types of sprinkler systems and many versions of each. The types are: hand move, tow line, side roll, side move with and without trailer lines, center pivot self-propelled, straight lateral self-propelled, giant sprinklers, and solid set.

Hand Move

The hand-move, portable-lateral system has long been used to irrigate more than any other. Labor requirement is about 1 man-hour per irrigation effort to move one-quarter mile of lateral. Although no major changes in this type of sprinkling equipment have been made in the last decade, all other types evolved from this one because of its limitations.

Tow Line

The tow line lateral system has fixed or swiveled, two-wheeled carriages which support the sprinkler pipe at intervals of 40 to 60 feet. These hold the pipe a foot or more above the ground. To move the lateral from one setting to the next it is end-towed by truck or tractor. Metal skid pans have replaced wheels in some versions of this system. These types are used to irrigate only a relatively small acreage.

Side Roll

The side roll system was developed during the late 1940's. Wheels were clamped around the coupler of each joint of hand-move sprinkler lateral, and the first kind of power for moving the mechanism was bicycle pedalling. One or two small gasoline engine-powered movers are used today to move a quarter mile of a side roll lateral. One manufacturer is marketing an engine-driven, hydraulic-powered unit. The mover units require the irrigator to walk considerable distances to start the gasoline engines.

To further reduce labor, equipment has been developed to operate the mover units from the mainline end of the side roll lateral. These end-move devices include a gasoline engine-driven shaft, tractor-driven hydraulic mover, and an electric mover unit driven and controlled from a tractor-powered electric generator.

Manufacturer of the engine-driven mover later installed remote control electric starters and made control of the unit possible by hydraulic operation from the mainline end of the lateral.

Side Move

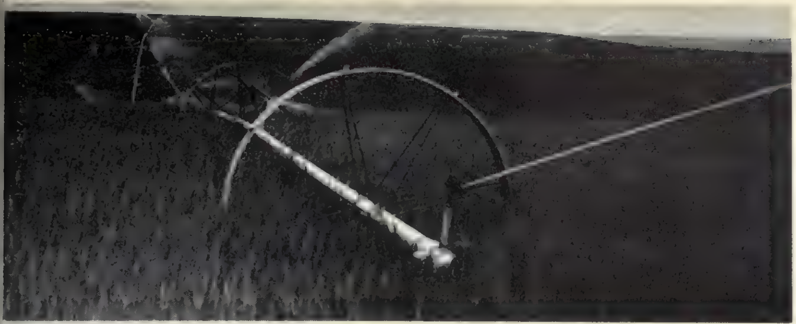
The side move system was developed to place the sprinkler above tall-growing crops such as corn. The main lateral pipeline is supported at 50- to 60-foot intervals with a two-wheeled carriage arrangement. Each wheel is powered from a line shaft by a belt, chain drive, or gear. The line shaft power is a small 6- to 10-horsepower gasoline engine located at the middle of the lateral.

Another version uses electric motors to move sections of the line shaft.

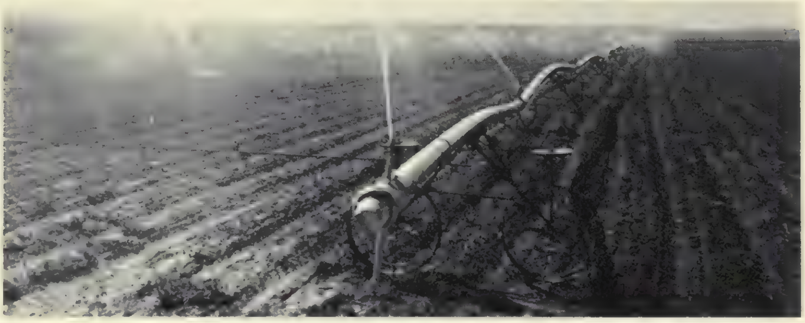
Quick opening automatic valves are installed along the lateral to drain water from the system before moving. Trailing pipelines varying in diameter from 1 to 2 inches are used on some systems. The lateral and trailer lines are moved by the power unit both at one time. From one to seven sprinklers are mounted on each trailer line making the seven-sprinkler trailer line system equivalent to eight hand-move laterals.

Stabilizers are used on the trailer lines to keep sprinkler heads vertical and improve water distribution. Stabilizers may be attached to the sprinkler-head risers or on the trailer line itself.

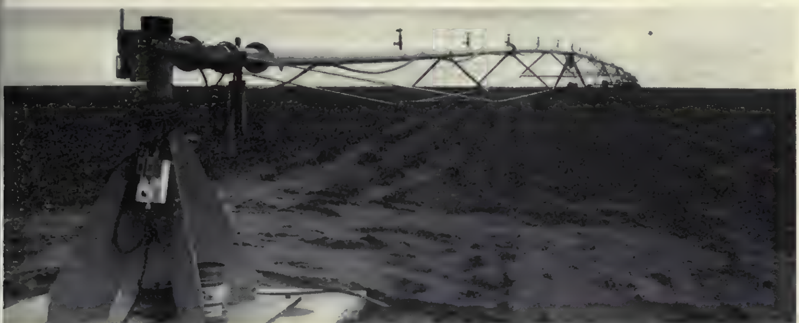
When it comes time to transport the side move system from one field setting to another, adjustable carriage wheels or an extra set of wheels, allow it to be end-towed, using a truck or tractor. Trailer



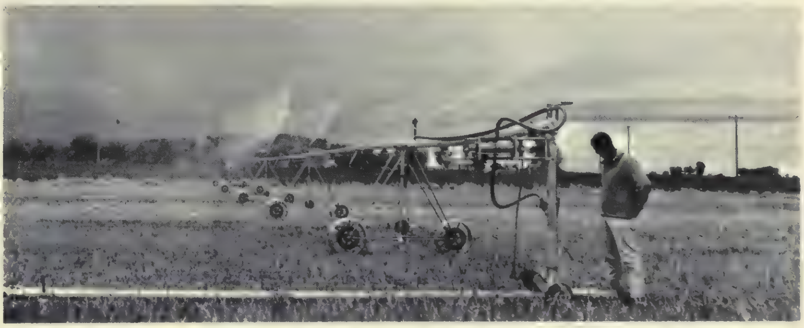
Side roll system.



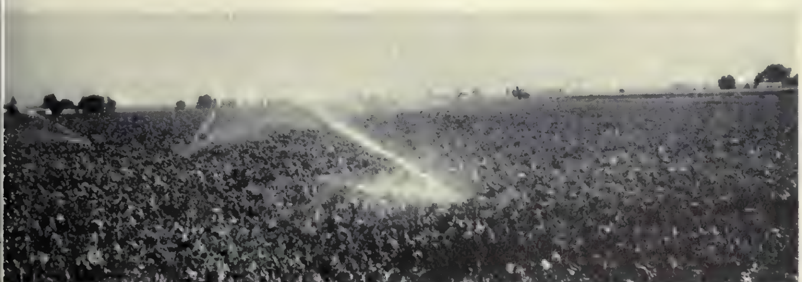
Side move system.



Center pivot.



Straight lateral, moving self propelled system.



Sequencing solid set system.

pipelines are loaded on an attached rack or carriage for the moving process.

Center Pivot, Self-Propelled

A center pivot, self-propelled continuously moving system has a lateral pipeline which is anchored at the center of the irrigated area and swings like a huge clock hand around its full circle. Water is introduced into the lateral at the center from either a well, irrigation canal, or stream.

Sprinklers varying in type, nozzle size, and discharge capacity are spaced at intervals along the lateral with the largest discharge at the furthest point from the pivot where the field area to be irrigated is larger. The design is such that uniform water distribution occurs along the lateral.

Speed of this sprinkler rotation can be varied so that from 15 hours to 7 days are required to complete one revolution. The slower the lateral rotation, the greater the depth of water applied. The depth of water applied is determined by a combination of sprinkler nozzle size, nozzle pressure, spacing of sprinklers on the lateral, and speed of rotation.

The center pivot, self-propelled lateral systems move along on wheels, crawler tractor tracks, or skids. Wheel versions are powered by water-driven, hydraulic cylinders, rotating arm type sprinklers, or electric motors. The skid type is pushed forward by a hydraulic-powered walking foot.

The lateral pipeline in most centered pivot, self-propelled systems is rigid pipe, but one system has flexible joints at each support point which permits satisfactory operation on uneven terrain. All systems have built-in safety devices that stop the lateral if a section gets out of alignment.

Straight, Self-Propelled

The straight, self-propelled lateral is a continuously moving system operated by water pressure. Each 40-foot section of pipe is supported on a two-wheeled A-frame. Each wheel is chain powered from a drive shaft. High-pressure hose which must also be flexible, connects the lateral to the mainline, and its rate of travel varies from 7 to 25 feet per hour.

Rate of travel of the straight, self-propelled lateral is adjusted by changing the nozzle size in the sprinkler that discharges water from the hydraulic drive mechanism.

Self-propelled lateral systems have been more highly advertised and popular in recent years because of the shortage of irrigation labor. A recent count showed 39 manufacturers of center pivot self-propelled sprinklers.

Giant Sprinkler

The giant sprinkler system may consist of one or more sprinklers discharging from 100 to several hundred gallons per minute over an area 200 feet or more in diameter. Originally this system was an enlarged version of the hand-move field sprinkler, but now they may involve a rotating boom with multiple nozzles. Boom arms up to 125 feet in length on each side of the pivot point were developed for use in tall-growing crops.

The giant sprinkler systems have been mechanized by being mounted on a trailer for easy movement by tractor or truck. A high pressure flexible hose is used in combination with a gasoline motor-driven winch to convert to a moving sprinkler system that pulls itself back and forth across a field. The flexible pipe is abrasion-resistant and can be dragged around guides to the new location or rolled on a reel and transported to the next setting.

Solid Set

Solid-set systems have been used with certain crops for several years. They may have either portable surface, or permanent underground pipelines. The solid-set portable pipelines are moved only to allow cultivating and harvesting.

Systems may be operated in blocks of laterals with all sprinklers on a lateral operating simultaneously. Some systems have pressure-operated sequencing valves that allow operation of one or more sprinklers on each lateral at one time. With this type, a momentary interruption of the water pressure shuts off the operating sprinkler heads and turns on the next sprinkler. A timeclock is used to control the momentary pressure interruption by closing an electric valve or shutting off a pump.

Waterflow can be completely automated on these systems. The solid-set systems also may be used for frost protection, application of fertilizers, insecticides, and crop cooling.

Efficiency Tests

At several field installations in the Boise Valley and Twin Falls areas of Idaho, tests and evaluations were completed on five of the sprinkler systems to determine their uniformity of water dis-

ibution and maximum application rates. At the eld sites, open-topped cans of 1-quart size were et out on 10-foot square grids over the area to be overed by the sprinklers. The sprinklers were perated several hours and the amount of water aught in each can was measured.

From these measurements the uniformity of ater distribution and maximum application rates ere determined.

Wind speeds also were measured during the ests.

Because three different sprinklers were tested multaneously in one case, wind conditions were niform in that particular instance. These three lso had the same type of sprinkler heads, prinkler nozzle, and nozzle pressure. The prinklers were the hand move portable, straight elf-propelled, and side-move with trailer lines.

To determine uniformity of water distribution, f all test cans in a sprinkled area had caught the ame amount of water, the score (or coefficient of niformity) would have been 100 for the test of hat sprinkler. Variations in the depths of water aught meant a reduced score, the greater the variation the smaller the score. A score of 80 is considred the lowest acceptable performance of a prinkler.

Under high windspeed (13 miles per hour) two ests of the side-roll system resulted in scores of 1 and 76. But in two tests under windspeeds of nly 1.9 miles per hour, the scores were 86 and 89.

The sequencing solid-set sprinkler received cores of 75, 75, and 78 under windspeeds of 6, 5.5, nd 4.8 miles per hour respectively.

Scores of 81 and 86 were made by the center ivot, self-propelled sprinkler with wind velocities f 7.1 and 6 miles per hour respectively.

The straight lateral self-propelled coefficients vere 89, 89, and 90 under winds of 6, 3.2, and 2.9 niles per hour.

Wind of about the same velocities as those just oted, occurred during four tests of the side move vith trailer lines, and resulted in cofficient scores f 84, 86, 87, and 88.

Rate of Application

The rate of maximum water application was calulated by dividing the measurement of the can atching the most water by the length of time vater was applied. These sprinkler measurements re of interest because if the application rate execds the intake rate of the soil, the water distribuion pattern of the sprinkler will be altered by a resulting runoff. Also pertinent is that many soils have varying rates of water absorption, so an excessive runoff might result from some sprinklers.

With the side roll lateral, the maximum water application rate exceeded .32 inches per hour (inch-hour) at high winds, while at low wind the rate was less than a .20 inch-hour. The sequencing solid set had maximum application rates of a .24 inch-hour, the straight self-propelled a .18 inch-hour, and the side move with trailer lines a .42 inch-hour of water.

The center pivot, self-propelled system had a variable application rate, the smallest being at the pivot point a .21 inch-hour and the highest at the last tower a 1 inch-hour. Excessive runoff could be a factor with this system.

When the hand move, straight self-propelled and side move with trailer lines systems were tested simultaneously, the water distribution uniformity was best for the straight self-propelled; the hand move was second, and the side move with trailer lines was third.

All systems tested gave good water distribution under low windspeeds except the sequencing solid-set system, on which the head spacing was too wide.

General Requirements

Each type of system has its advantages and disadvantages. Some systems can be designed for use on almost all lands, whereas others have limited applications. Regardless of the type of system used, it should meet certain requirements:

(1) The application rate should not exceed the ability of the soil to absorb water. Runoff water is evidence of too high an application rate.

(2) The amount of water applied during an irrigation should not exceed that which can be held within the root zone of the crop unless leaching to remove harmful salts is desired.

(3) The system should be of such a size and capacity that it is able to replenish the soil moisture at a rate equal to the peak rate of water use by the crops irrigated.

(4) Water should be applied as uniformly as practical over the field. The point of lightest application should receive at least 80 percent as much water as the average application for the field.

(5) Distribution pipes should be of large enough diameter so that there is an economic balance between pipe cost and power cost.

(6) Water must be applied in a way that will not physically damage the crop. # # #

$812.3 million per year from irrigation

BIG $$ IMPAC

by RICHARD F. BARBER, Jr.,
Regional Economist, Grand Island

BETWEEN rocky bluffs and such landmark mounts on western prairies were spread miles of plains over which travelers made their way years ago. When they used that section of the Oregon Trail which traversed Nebraska prairies, Scottsbluff always was one of their reliable landmarks.

Many of these travelers stopped at likely prairie locations along the way, took plows from their wagons and tried them. Generally the soil they prepared was fertile. But most of the thirsty crops did not get a wetting before withering and dying.

In making Nebraska the thriving State it is today, a big change was made. Major benefits in terms of dollars, and other obvious ways, have resulted from the growth of irrigated agriculture. It is the primary reason that agriculture is the State's dominant industry. The once parched prairie around the majestic Scottsbluff—as only one of the soil-rich areas—now includes irrigated fields of lush alfalfa from which a farm operator profits with multiple harvests annually.

So many men have taken the opportunity for irrigation farming in Nebraska, that more than 3 million acres are now under irrigation—the third highest State in such acreage. A greater percentage of the cropland is without irrigation. But it is revealed in an economic impact study that the value of crops which farmers were able to produce by irrigation exceeded equivalent dryland farm values by $121.6 million in only 1 year.

(*Continued on page 30.*)

Left. Art Weinhold, Gering Valley farmer examines his new potatoes. Right. Tomatoes grown on a Reclamation irrigation project in Nebraska are being hauled to cannery in Colorado.

N NEBRASKA

(*Continued from page 28.*)

Suppliers $157 Million

That year, 1963, is when the Census of Manufacturers was available for analysis. The recently completed penetrating study of that census and other data showed that businesses providing farm products and services, direct and indirect—being induced by the large irrigation production in the State—received sales increase of $157 million. This is 29 percent greater than the farm production increase.

Businesses which received the $157 million supplied such wide ranging items as machinery, fertilizer, seed, and other commodities farmers need for growing crops.

Meanwhile, the sales increase to the business sector which handles and processes the irrigation production, was $534 million for the year. This is a comparison of $4.39 to $1, referring to use of the products in the greater segment of the economic community such as households; and by such manufacturers as mining, metals, and machinery; and such businesses as livestock, finance, insurance, real estate, and transportation.

In other words, the high value of irrigation for 1963 increased the total business volume by $812.3 million, or about $300 per irrigated acre, figured in view of the slightly more than 3 million irrigated acres in the State.

Although there are 40 million acres of land under irrigation in the United States, few people understand or appreciate the chain reaction of benefits which results from the productivity of these lands. For this reason the Bureau of Reclamation has sponsored economic impact studies of this and other irrigation areas.

A study completed in 1966, in cooperation with Washington State University, focused on the economic significance of the Columbia Basin water development project in the State of Washington.

This economic analysis, was completed by the University of Nebraska's Bureau of Business Research under contract with Reclamation. The Nebraska study team was headed by Dr. Theodore W. Roesler, professor of economics. He was aided by Dr. F. Charles Lamphear, associate professor of economics, and David Beveridge, a student Ph. D. candidate.

Roesler and Lamphear were able to work full time on the project from July 1967, to September 1968.

A plow bites into the fertile soil of the North Platte Irrigation Project, Nebr., an historic immigrant wagon trail area.

Research Methods

Census statistics were augmented by questionnaires and personal interviews which enabled the researchers to sample from 22 to 89 percent of industries within specific categories operating in the State.

The Cornhusker State of 1.5 million persons rates fifth in corn production and sheep feeding. However, it is first in the production of alfalfa meal, wild hay, and Great Northern beans. It is second in grain-fed cattle marketed, and in commercial livestock slaughtered.

It is third in sorghum production, grain storage capacity, and number of cattle. It is fourth in wheat production.

Of the 3.3 million acres irrigated in Nebraska in 1967, about 420,000 were supplied with water from facilities constructed by the Bureau of Reclamation.

Growth of irrigation in the postwar period has been rapid and shows a significant future potential. Between 1947 and 1963, the value of total crop production produced on irrigated land increased from 10 percent to 27 percent.

A significant $3.5 billion of increased business activity was generated during the 20-year period

om 1946–65 directly by the farmers and by busi-sses where farmers make purchases for their ag-cultural production.

Industry stemming from processing farm goods as not studied in detail for the 20-year period, it was estimated in the study to be at least an-her $6.5 billion, producing an overall economic ipact of more than $10 billion over the 20 years.

While the effects of this increased activity due irrigation extended well beyond the State, no tempt was made to measure its economic impact. owever, it is significant that in 1963 an estimated percent of Nebraska's irrigated crop production as sold outside the State.

For a State of "parched prairies"—but of pro-uctive action which only irrigation developments uld have caused—Nebraska is making a valuable ipact on the Nation. # # #

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

BSCRIPTIONS TO "ERA" ARE ONLY $1.50 PER EAR AT GOVERNMENT PRINTING OFFICE, WASH-GTON, D.C. 20402.

AIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. DOCS.	

Enclosed find $______________ (check, money order, or Documents coupons). Please enter y subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; cents per single copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code______________________________

As the Nation's principal conservation agency, the Department of the Interior has basic responsibili-s for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs e other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6697	Colorado River Storage, Ariz.	June 6	One 345- and one 230-kv spare power transformers for Glen Canyon powerplant.	Brown Boveri Corp., North Brunswick, N.J.	$352,6
DC-6718	Southern Nevada Water, Nev.	Apr. 24	Construction of pumping plants No. 4, 5, and 7, forebay tanks No. 4 and 5, regulating tank No. 7, and switchyards No. 4 and 5.	R. E. Ziebarth and S. B. Alper, Torrance, Calif.	1,574,4
DS-6720	Columbia Basin, Wash.	Apr. 23	Three 525-kv autotransformers for Grand Coulee consolidated 230-kv switchyard, Grand Coulee third powerplant.	Hitachi New York, Ltd., San Francisco, Calif.	825,6
DC-6721	Colorado River Front Work and Levee System, Ariz.	Apr. 9	Construction of 11.5 miles of pipelines for Yuma Mesa conduit and collector conduits, Yuma Mesa well and field conduit.	M. M. Sundt Construction Co., Tucson, Ariz.	1,311,6
DC-6722	Missouri River Basin, S. Dak.	Apr. 10	Construction of stage 05 additions to Fort Thompson substation.	Commonwealth Electric Co., Lincoln, Nebr.	1,617,7
DC-6723	Central Valley, Calif.	May 2	Construction of Judge Francis Carr powerplant bypass at Clear Creek tunnel Sta. 457+10.	S & Q Construction Co., South San Francisco, Calif.	504,9
DC-6724	Colorado River Storage, Ariz.	Apr. 16	Installation of four 345-kv series capacitor banks for Flagstaff and Pinnacle Peak substations.	Jelco, Inc., Salt Lake City, Utah	609,0
DC-6725	Chief Joseph Dam, Wash.	Apr. 15	Completion of Whitestone Flats and North Branch pumping plants.	Paul E. Hughes Construction Co., Inc., Tri-Cities, Wash.	237,5
DC-6728	Central Valley, Calif.	May 5	Construction of substructure for Auburn-Foresthill bridge.	Hensel Phelps Construction Co., Burlingame, Calif.	2,971,8
DC-6734	Central Valley, Calif.	June 11	Construction of 4.3 miles of concrete lined Tehama-Colusa canal and fish facilities, Reach 1.	Gibbons and Reed Co., Jelco, Inc., and Clyde W. Wood and Sons, Inc., Salt Lake City, Utah.	9,110,7
DC-6735	Minidoka, Idaho	May 6	Construction of additions to Minidoka 138-kv Interconnection substation for Unity Line terminal.	C-L Electric Co., Pocatello, Idaho	233,8
DC-6737	Missouri River Basin, Nebr.	May 16	Construction of Grand Island substation, stage 01	Richards & Associates, Inc., Carrollton, Ga.	1,177,4
DC-6742	Missouri River Basin, S. Dak.	May 26	Construction of stage 04 additions to Summit substation.	United Power, Contractors & Engineers, Inc., Seattle, Wash.	260,2
DS-6746	Colorado River Pilot, Atmospheric Water Resources, Colo.	June 5	One lot of instrumentation equipment for hydrometeorological automatic data acquisition.	E G & G, Inc., Environmental Services Operation, Boulder, Colo.	190,7
DC-6752	Colorado River Front Work and Levee System, Ariz.	June 13	Construction of Lower Cibola bridge	Tidmarsh Engineering Co., Tucson, Ariz.	339,0
DC-6753	Missouri River Basin, Kans.	June 11	Relocation of 7.3 miles of Mitchell County Highway C-480 and township roads No. 51, 77 and 78.	Industrial Builders, Inc., Fargo, N. Dak.	575,1
DS-6755	Columbia Basin, Wash.	June 18	Furnishing and installing two armature windings for generator units R-1 and L-1 for Grand Coulee right and left powerplants.	Westinghouse Electric Corp., Denver, Colo.	484,5
100C-1048	Columbia Basin, Wash.	Apr. 4	Construction of 11.7 miles of buried pipe drains for D45-17, -23, -39, -42, -275 and D46-36B drain systems, Block 45.	Equipco Contractors, Inc., Ephrata, Wash.	199,7
100C-1056	Columbia Basin, Wash.	May 5	Construction of 9 miles of buried pipe drains for D16-264, -265, -266 drain systems and D16-309-2 drain, Block 16.	John M. Keltch, Inc., Pasco, Wash.	143,4
100C-1057	Columbia Basin, Wash.	May 23	Construction of 20 miles of buried pipe drains for D15-65 and -79 drain systems and D15-79 pumping plant, Block 15.	Equipco Contractors, Inc., Epharta, Wash.	416,6
300C-287	Colorado River Front Work and Levee System, Ariz.-Calif.	Apr. 4	Developing sources, producing and stockpiling riprap and gravel near Yuma, Ariz.	M. J. Baxter Drilling Co., El Cajon, Calif.	159,9
500C-283	Pecos River Basin Water Salvage, Tex.	May 26	Clearing Pecos River from Texas-New Mexico State line to Orla, Tex.	J. H. Ryan and Sons, Inc., Albuquerque, N. Mex.	150,0

RECENT BID REQUESTS*

Project	Description of work or Material
Boulder Canyon, Nev.	Constructing two reinforced concrete, 5-million-gallon-capacity storage reservoirs with depths of 31 ft, and reinforced concrete roof supported on columns; constructing an outdoor-type pumping plant with four risers for motor-driven, vertical-shaft, turbine-type pumps of 1,500-gpm capacity at 125 ft of head, each pump to be driven by a 75-hp motor; and furnishing and installing two pumping units, two cylinder operated pump cone valves and valve-operating system, and remote and automatic control system. Excavation for reservoirs, 55,000 cu yd; excavation for ditches, 21,000 cu yd; excavation for pipe trenches, 20,000 cu yd; Backfill, 28,000 cu yd; concrete in structures, 5,200 cu yd; reinforcing steel, 1,200,000 lb; 14- to 36- in.-diameter asbestos-cement, pretensioned, steel or concrete pressure pipe, 6,000 ft; metal pipe fittings and valves, 87,000 lb; cast iron, motor-operated slide gates. Boulder City.
Central Utah, Utah.	Earthwork for constructing about 1 mile of 12-ft-wide road at Starvation Dam. Six miles northwest of Duchesne.
Central Valley, Calif.	Modifications of fish trap superstructure will include complete dismantling of existing damaged tower; removal of existing electrical equipment, lighting fixture, conduit, and wiring; furnishing and installing and reinstalling as required new and salvaged electrical equipment, lighting fixtures, conduit, and wiring; furnishing as required new members for fish trap superstructure; reerecting existing tower on existing foundations with new members as required; modifying hopper nozzle, and removing and replacing hand-operated float valve winch and cable. At Keswick Dam near Shasta.
Central Valley, Calif.	Constructing a 5,200-sq-ft O&M building, a 5,700-sq general maintenance warehouse and shop building, a a 2,800-sq-ft vehicle maintenance building. Each buil ing is to be slab on grade with steel frame, metal ro decking, and concrete masonry wall filler panels. Wo will also include constructing a water pumping static with treatment facilities, and a septic tank with di posal field; grading, curbs, and gutters; bitumino surfacing; landscaping; and fencing. Approximate ar of site is 14 acres with about 6 acres receiving pavemen buildings, and landscaping. About 15 miles northea of Coalinga.
Central Valley, Calif.	Earthwork, structures, and surfacing for the followi access roads: 1.5 miles on the right abutment; 2.3 mil to the powerplant site; 1.8 miles on the left abutmen and 3.0 miles to the diversion tunnel. Auburn Damsi near Auburn.
Colorado River Front Work and Levee System, Calif.	Constructing about 6,250 ft of low embankment alo the edge of the river. About 30 miles south of Blyth
Colorado River Front Work and Levee System, Ariz.-Calif.	Removal of snags from Lake Havasu. About 40 mil south of Needles, Calif.
Colorado River Storage, Colo.	Earthwork, culverts, and fence gates for rehabilitati about 97 miles of existing roads, and constructing abo 22 miles of new roads. Between Rifle and Hayden.

U. S. GOVERNMENT PRINTING OFFICE : 1969 O - 352-430

RECENT BID REQUESTS*—Continued

Project	Description of work or Material
olorado River Storage, Colo.	Storage program, programable master station supervisory control equipment for control of Morrow Point Powerplant, Rifle and Midway substations from Montrose Power Operations Center
olumbia Basin, Wash.	Constructing about 33 miles of buried pipe drains. Block 82, west of Royal City.
Do	Constructing about 21.5 miles of buried pipe drains and 0.6 mile of open drain. Excavation and backfill of drainpipe trenches, 87,000 cu yd; excavation for open drain, 5,000 cu yd; excavation for structures, 1,000 cu yd; backfill about structures, 700 cu yd; compacting backfill, 700 cu yd; graded filter material, 12,000 cu yd; drainpipe, 110,000 lin ft; 24-in. corrugated-metal pipe, 100 lin ft; manholes, 60. Block 77, west of George.
Do	Constructing about 18 miles of buried pipe drains and 0.4 mile of open drain. West of Othello.
Do	Constructing about 0.8 mile of buried pipe drain extension in Block 72; 400 ft of buried pipe drain extension in Block 73; and about 1.6 miles of buried pipe drain in Block 79. Excavation and backfill of drainpipe trenches, 9,900 cu yd; excavation for structures, 200 cu yd; backfill about structures, 100 cu yd; graded filter material, 800 cu yd; overhaul, 200 Mi cu yd; drainpipe, 8,230 lin ft; 8- and 15-in. corrugated-metal pipe, 60 lin ft; manholes, 6. Quincy.
olumbia Basin, Wash.	Placing earth lining in about 900 ft of EL69E lateral and in about 1,800 ft of EL16C lateral, Block 40; placing earth lining in about 4,200 ft of EL20Z1 lateral, Block 41; and placing earth lining in about 2,800 ft of EL31B lateral, Block 42. East of Moses Lake.
Do	Fencing about 20 miles of four-strand, barbed-wire fence and accessories along the right-of-way of the fourth section of the Wahluke Branch Canal. East of Mattawa.
Do	Placing beach belt protection on both sides of about 16,500 ft of canal. Wahluke Branch, West of Othello.
Do	Ten 525-kv, 236,000-kva, single-phase power transformers and nineteen 396-kv lightning arrestors. Grand Coulee Third Powerplant.
Denver Office, Colo.	Constructing a new 3-in.-thick reinforced lightweight concrete deck slab on the plaza of Building 67. (Area of deck is about 52,000 sq ft.) The slab will be exposed aggregate with smooth concrete feature strips. Reinforcement to be 6x6—10x10 welded wire fabric. Expansion joints at about 30-ft centers and saw cut control joints at 5-ft centers. A 10 mil polyethylene slip sheet will be required over existing hardboard membrane protection sheet. Removal of existing plaza deck, new water proofing and hardboard protection sheet will be by others. Denver Federal Center.
Fryingpan-Arkansas, Colo.	Clearing about 11 miles of abandoned railroad roadbed of bridge materials, communication line poles and old ties, and stockpiling about 15,000 ties near Pueblo damsite. Near Pueblo.
Do	Earthwork and structures for 2.3 miles of 18-ft-wide, unsurfaced tunnel access road. Nast Tunnel Access about 25 miles east of Basalt.
MRBP, Iowa	One 3-phase, 154–69–13.8-kv, 30/40/50-mva autotransformer. Denison Substation.
MRBP, Minnesota.	Constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 115-kv power circuit breaker, and associated electrical equipment. Excavation for structures, 100 cu yd; concrete, 50 cu yd; reinforcing steel, 2,500 lb; structural steel, 11,000 lb. Morris, about 4 miles west of Morris.
Do	Additions to the Granite Falls Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing three 230-kv and one 115-kv power circuit breakers, and associated electrical equipment. About 0.5 mile north of Granite Falls.
MRBP, Montana	Earthwork and structures for about 16,900 ft of closed drains utilizing 6-through 12-in. drainpipe. Helena Valley Unit, near Helena, Mont.
Do	Constructing about 1,000 ft of open drains and about 19,500 ft of closed drains. Excavation for open drains, 500 cu yd; excavation and earth backfill for closed drain trenches, 14,000 cu yd; excavation for structures, 200 cu yd; backfill about structures, 100 cu yd; gravel backfill in closed drain trenches, 1,500 cu yd; coarse gravel backfill in closed drain trenches, 200 cu yd; drainpipe, 19,780 lin ft; manholes, 12. East Bench Unit near Dillion.
Do	Preparation of about 10,000 ft of East Bench Canal subgrade and installation of asphaltic membrane or polyvinyl-chloride lining and lining cover. Canal bottom width is 18 ft. Near Dillon.
Do	Preparation of about 9,800 ft of Helena Valley Canal subgrade and installation of asphaltic membrane or polyvinyl-chloride lining and lining cover. Canal bottom width is 16 ft. Preparation of subgrade and placement of slip-firm concrete lining in about 2,200 ft of Lateral 27.8–0.7. Near Helena.
MRBP, Nebraska.	Constructing about 1.3 miles of 8- to 12-in. subsurface drain varying in depth up to 10 ft, excavating about 0.4 mile for pilot channel, and improving 0.6 mile of drain channel. Ten miles west of Red Cloud.
Do	Selective clearing of trees immediately adjacent to stream banks, removal of logs and bebris from creek channel, and channel widening on restricted waterway openings in selected reaches of Frenchman Creek. Between Enders Dam and Palisade.
Do	Constructing about 1.7 miles of closed drain varying in depth up to 10 ft. Cambridge Canal near Edison.
MRBP, North Dakota.	Constructing about 2 miles of open channel with a bottom width of 6 ft and excavation cuts varying from 2 to 15 ft. Work will also include constructing a control structure at the inlet end of the channel, corrugated-metal pipe road crossings, and drain inlets. Painted Woods Outlet Channel about 10 miles northwest of Regan.
Do	Additions to Fargo Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 230-kv and one 115-kv power circuit breakers, and associated electrical equipment. About 8 miles southwest of Fargo.
Do	Additions to the Edgeley Substation will consist of grading the extension; constructing a 23- by 45-ft concrete masonry service building; constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing two 115-kv power circuit breakers, and associated electrical equipment; and fencing the additional area. Excavation for grading, 1,200 cu yd; excavation for structures, 400 cu yd; compacting embankments, 1,000 cu yd; concrete, 80 cu yd; reinforcing steel, 9,300 lb; structural steel, 29,000 lb. About 1 mile east of Edgeley.
MRBP, South Dakota.	Additions to the New Underwood Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 230-kv and one 115-kv power circuit breakers, and associated electrical equipment. About 2 miles south of New Underwood.
Do	Constructing a 60- by 120-ft O&M building, including area grading and drainage facilities. The building will be a combination of reinforced concrete and masonry construction with a precast prestressed double tee roof. A grade beam-caisson foundation is to be used. Huron Service Center, Huron.
MRBP, Wyo	Additions to Kortes Switchyard involves work to be performed on the powerplant transformer deck and on the switchyard platform of the dam. The additions will consist of constructing concrete pads; furnishing and erecting steel structures; and furnishing and installing one 115-kv disconnecting switch, three 115-kv coupling capacitors, and associated electrical equipment. About 60 miles southwest of Casper.
Do	Additions to the Alcova Switchyard will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 115-kv power circuit breaker, and associated electrical equipment. Excavation for structures, 400 cu yd; concrete, 60 cu yd; reinforcing steel, 7,000 lb; structural steel, 29,000 lb. About 30 miles southwest of Casper.
Do	Constructing about 29 miles of single-circuit, 3-phase, 115-kv transmission line; furnishing and erecting wood-pole structures; constructing concrete foundations; furnishing and erecting seven steel-pole structures; furnishing and stringing three 397.5 MCM, ACSR conductors and two ⅜-in. steel strand overhead ground wires; removing about 1 mile of existing distribution and communications line; and furnishing and installing about 1 mile of 600-volt power cable and a communication cable underground. Kortes-Alcova East southwest of Casper.
Navajo Indian Irrig., N. Mex.	Constructing the 15,550-ft-long Tunnel No. 3, to be either an 18-ft-diameter circular or a 17.5-ft-diameter horse-shoe tunnel; constructing the 3,423-ft-long Tunnel No. 3A, to be either an 18-ft-diameter circular or a 17.5-ft-diameter horseshoe tunnel; constructing two 17.5-ft-diameter, monolithic concrete siphons with a total length of 754 ft; and constructing 11,800 ft of concrete-lined canal with a 23-ft bottom width and 11.8-ft water depth. Munoz and Munoz Branch Siphons from 30 to 35 miles southeast of Farmington.
Pacific NW-Pacific SW Intertie, Calif.	Furnishing and installing about 140,000 ft of counterpoise grounding wire. Malin-Round Mountain Transmission Line in Modoc, Siskiyou, and Shasta Counties.
Pacific NW-Pacific SW Intertie, Nev.	Minor modifications to existing steel structures; constructing concrete foundations; and installing communication, supervisory, metering, and relaying equipment. Hoover Powerplant and Switchyards.
Teton Basin, Idaho.	Work will consist of a pilot foundation grouting program. Drilling foundation grout holes, in stage, maximum depth 310 ft, 8,000 lin ft; foundation grouting, 20,000 cu ft. At Teton Damsite.

*Subject to change.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

THE NATURAL RESOURCES OF OUR STATES

Take a statewide tour through the State of your choice via the Department of the Interior's State Resource Booklet Series. Whether your interests are travel, recreation, scenic beauty, industrial development, recreational opportunities, or the programs for conserving the natural resources of the State, these booklets provide illustrated, easy-to-read answers.
Available States listed on mail order coupon below.

Street address ....

Name ....

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

POSTAGE AND FEES
U.S. GOVERNMENT PRINT

MAIL ORDER FORM To:

Superintendent of Documents,
Government Printing Office, Washington, D. C. 20402

Enclosed find $.................. (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

- _ Alaska. I 1.91:Al 1s 65¢
- _ Texas. I 1.91:T 31 45¢
- _ Arizona. I 1.91:Ar 41 45¢
- _ Massachusetts. I 1.91:M 38 45¢
- _ Colorado. I 1.91:C 71 50¢
- _ Oregon. I 1.91:Or 3 50¢
- _ Nevada. I 1.91:N 41 45¢
- _ California. I 1.91:C 12 60¢
- _ Indiana. I 1.91:In 2 45¢

- _ Montana. I 1.91:M 76
- _ West Virginia. I 1.91:W 52 V
- _ Ohio. I 1.91:Oh 3
- _ Washington. I 1.91:W 27
- _ New Mexico. I 1.91:N 42 M
- _ Idaho. I 1.91:Id 1
- _ Utah. I 1.91:Ut 1
- _ South Dakota. I 1.91:So 8 D
- _ Wyoming. I 1.91: W 99

Name ....

Street address ....

FOR USE OF SUPT. DO

November 1969

RECLAMATION era

A WATER REVIEW QUARTERLY

November 1969 Vol. 55, No. 4

RECLAMATION era

Gordon J. Forsyth, Editor

Contents

COVER ART. The environs of Grand Coulee Dam are visualized as a showplace of Man's ingenuity and the wonders of nature.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Floyd E. Dominy Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

Water News

The story of a dam in the West is the story of people—towns spring up and productive living is brough to an arid area of the Nation.

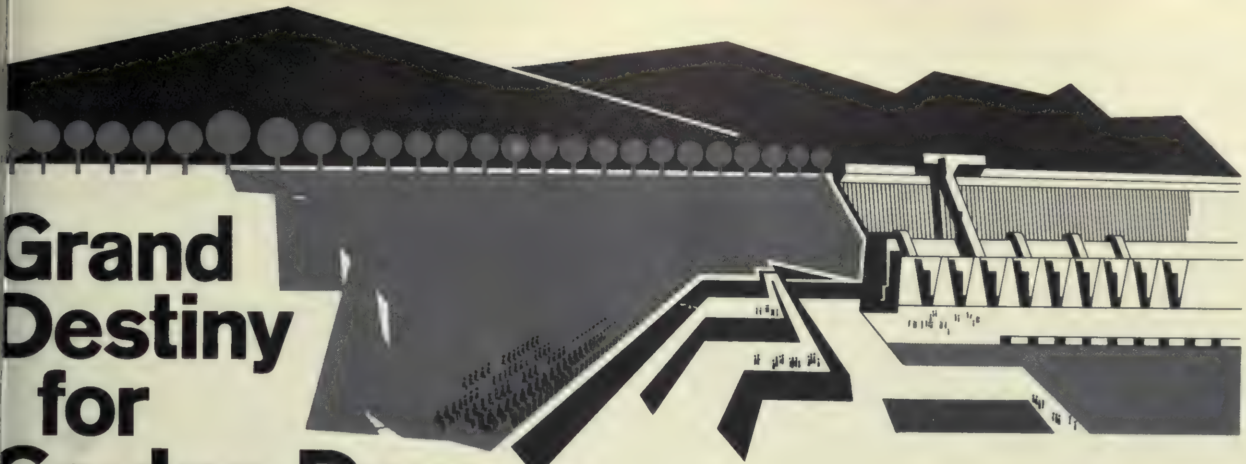
A dam which provides critical water supplies t an industrious people in a semi-arid area of Utah ha recently been named: Arthur V. Watkins Dam, whic until last October was called Willard Dam. Renamed i honor of Utah's former U.S. Senator Arthur V. Watkin this 14.5-mile structure makes a fresh water lake out o the Willard Bay arm of the Great Salt Lake.

Senator Watkins' distinguished public career fo many years included water program leadership both in hi home State and in Washington, D.C. He is now living i retirement in Utah.

The newly named dam also was recipient of an other distinction this year. On the 20th year since Con gress authorized it for construction, the dam—as part o the Weber Basin water project—passed from Federal t private operation. The project had been both built an operated by the Bureau of Reclamation, and now the re sponsibility of its operation and maintenance is handle by the Weber Basin Conservancy District.

Among the water features transferred—costin $38 million to build—are additional dams, water transpo and drain works for flood control, enhancing fish popula tion and growing crops. Related facilities constructed b the district will provide 50,000 acre-feet of water annuall for people's homes and industries.

Picnic areas, culinary water systems, docks an other facilities for recreational use have been constructe in the area by Job Corps youth of Reclamation's Webe Basin Civilian Conservation Center.—RE



Grand Destiny for Coulee Dam

EXUDING BEAUTY, PLAN IS SPURRED BY EXPERTS

by **OTTIS PETERSON**
Assistant to the Commissioner

A FAR-reaching landmark plan to upgrade the man-made environment at Grand Coulee Dam and Powerplant in Washington State has been presented to Federal, State, county, and community leaders by the Bureau of Reclamation.

Not yet a finished blueprint, the plan was undertaken 2 years ago by the firm of Kenneth W. Brooks, AIA, of Spokane, Wash., under contract with the Bureau of Reclamation.

It represents a major effort by the Bureau of Reclamation to point up the needed and potential improvements for the total environment of the dam and surrounding area—to meld the natural beauty of the area and its unique geologic history—to make a showplace of man's ingenuity and skill and the wonders of nature.

The proposed plan goes far beyond anything which could be undertaken exclusively by the Bureau of Reclamation, and will require participation by many agencies and communities if it is to succeed. Such groups have membership in a Grand Coulee Dam Advisory Council, which hopefully, will function in a leadership manner in reviewing and coordinating such aspects of the program as are agreed upon and may be undertaken.

Harnessing the flow of one of the world's great rivers, the Columbia, the awesome 4,173-foot-long Grand Coulee Dam has been a popular public attraction since it was first undertaken in 1933. Construction is now underway on a third powerplant, which will ultimately extend over 1,000 feet downstream from the right abutment of the dam. Excavation for the new powerplant and forebay dam is a bigger job than excavation for the original structure.

U.S. Canada Co-op

The third powerplant was made possible by practical upstream storage on the river and its tributaries in the United States and Canada. Presently authorized are an additional 3,600,000 kilowatts of capacity, which will be supplied by six great turbogenerators, each possessing 600,000 kilowatts of capacity—the largest in the world. A second bank of six similar turbines and generators will be possible at a later date, when authorized by Congress, giving a total project and installed ultimate capacity of 9.4 million kilowatts.

This will make the project once again one of the largest hydropower installations in the world. It is expected to be an even greater magnet for tourists and sightseers from all parts of the world,

One of the interesting valley views.

and the environmental plan is designed to place the manmade wonder in a suitable setting.

The Brooks environmental study could, when implemented, make a visit to the Grand Coulee area one to be long remembered. Contemplated as the major Bureau of Reclamation contribution to the effort is a doubletour circuit of the gigantic dam and powerplant, one of riding and one of walking, including visits to the inner recesses of the new powerplant.

This would be provided by an extraordinary outside inclined elevator from the crest of the forebay dam down to the third powerhouse, which was conceived by the world-renowned architectural firm of Marcel Breuer and Associates of New York City. A minitrain is envisioned to carry passengers around exterior areas.

A distinctive aerial cable car is proposed to carry visitors on a breathtaking ride from an arrival center downstream from the dam on the left bank to an exhibit center and museum on the scenic hillside high above the river. The hilltop provides an expansive view upstream of Franklin D. Roosevelt Lake, downstream toward Chief Joseph Dam, and westwardly to Banks Lake and the spectacular Coulee, carved out when an ice dam turned the river south many thousands of years ago. The bluff also offers an unexcelled view of Grand Coulee Dam, including the third powerhouse.

Hilltop Museum

To make the most of the hilltop, it is possible that a museum will be established there incorporating three phases: the geology of the area; the early history of Man, telling the story of the early migrations across Bering Strait from which many anthropologists believed the Indians came; and the history of modern Man.

The Brooks report envisions sweeping lawns and landscaping which would be utilized as a natural stage for sports events, pagentry, summer symphonies and other cultural events.

An extensive lighting operation is proposed to dramatize the flow of energy from the great generators.

One of the challenges is to improve and develop the community environs beyond the jurisdiction or authority of the Bureau of Reclamation. Recommendations for industry and community development including areas reserved for "21st Century" industry; development of an electric power research center, which is already under discussion; possibly an academic center; reserve the town of Coulee Dam West as the first model town; improve Coulee Dam East with emphasis upon a greenbelt and park atmosphere; restore living and service community.

The report suggests the Federal and State governments pool resources to build a modern shoreline village of permanent housing, easily convertible to vacation use at Banks Lake. All of Banks Lake would be utilized as a "unique experience" in recreation, camping, and relaxation. The lake has 100 miles of remote canyon shoreline and white sand beaches. The west bank would be available only by boat with campsites planned in such

Scenery lovers would enjoy studying the area from this hill.

a way as to be hidden and inaccessile by road.

A unique community high school is proposed. It would also be available for use as a convention center in summer. Existing high schools would be converted to elementary use.

The Bureau of Reclamation expects to cooperate and participate with the planning and development within the limits of the Federal jurisdiction, confined primarily to the physical structure of the dam and contiguous areas. The community challenge is to join in improving the approaches, the business areas, and the visitor accommodations in keeping with the natural beauty of the area.

# # #

Right. Nature's creations are plain,

Applied know-how would meet huge water demands

Coming Needs: 700% More City Water

A PHENOMENAL 700-percent increase in water supplies will be needed in the next 0 years for the municipal and industrial growth f the West, and there are programs underway and eing formulated to fill such a demand.

This water outlook was noted before the 15th Annual Rocky Mountain Mineral Law Institute t Vail, Colo., last July in a Bureau of Reclamation paper entitled: "Acquisition of Water from Federal Reclamation Projects for Industrial and Community Development."

This projected information—which is based on gures from the Bureau of Census, the National Water Resources Council, and the Bureau of Reclamation—indicates that the West will grow much faster than the rest of the Nation. Between 965 and the year 2020, the population of that part f the country will climb about 200 percent, as ompared to 150 percent for the Nation as a whole, nd 125 percent for the Eastern States.

While critical water demands of the 17 Western States' burgeoning communities will increase 230 ercent, the water requirements for manufacturing will increase 350 percent, and water required or steam-electric power generation will sky-rocket o around 2,200 percent. Much of the water needed, articularly that for steam-electric power generation, can be provided by use over and over again f available supplies and does not necessarily mean n increase in new supplies of these percentages.

700 Percent In West

The combined increases in municipal, industrial nd steam-electric needs during the next 50 years vill be about 700 percent in the West, 300 percent n the Eastern States, and 400 percent average for he Nation.

Large though these projected requirements are, here is much evidence that efficient use of the best technology, and meaningful efforts of the Nation would result in meeting the demand. The Bureau of Reclamation could more than quintuple the municipal and industrial water supplies included in its projects from 543.2 billion gallons in 1967 serving 13.7 million people—to 2.8 trillion gallons supplying the needs of 43.2 million people by the year 2020.

This means supplying municipal and industrial water for the needs of 26 percent of the population of the West. That capability would depend upon the Bureau getting funding to complete all of its projects now under construction and authorized, and all projects on which studies are now underway.

Reclamation's water storage facilities are supplying water in terms of the multipurpose concept, with the largest amounts of water being for production of food supplies for people throughout the Nation. Other purposes include supplies for people in cities, industrial uses, the generation of hydropower, as well as protection of the environment through flood control, sediment retention, fish and wildlife enhancement, and recreation uses.

Urban Population Growth, 1965–1975.

Even water for taking clean showers and other sanitary uses are some of the MUSTS in planning water supplies for the future.

Costs of multipurpose Reclamation projects allocated to municipal and industrial purposes are fully reimbursable with interest from the users.

Reclamation Potential

The Bureau of Reclamation has, in addition to greater emphasis on more economical use and possible re-use, three other large potential opportunities to contribute to meeting the West's municipal and industrial water demands of the future. These are the conception and development of new water projects, particularly in remote or relatively undeveloped areas . . . a potential shift in present water use on some existing projects where higher-use purposes have evolved . . . and the tapping of new sources not previously exploited, such as weather modification (drawing water from the clouds) and desalting of inland and sea water.

Potential users of water from Reclamation projects are: those people who live and work in communities whose present water supply is inadequate; similar groups who will need quantities to meet future demands; and industries desiring an assured water supply prior to becoming financially committed to a new business venture.

A number of Western towns and cities rely in some degree upon Reclamation's municipal and industrial water supplies. Examples are: Phoenix and Yuma, Ariz.; Las Vegas and Reno, Nev.; Los Angeles, San Diego, Sacramento, and Fresno, Calif.; Fort Collins and Greeley, Colo.; Salt Lake City, Ogden, and Provo, Utah; Rapid City, S. Dak.; Wichita, Kans.; Norman and Arbuckle, Okla.; and Brownfield, Lubbock, and Amarillo, Tex.

Among other topics covered in the paper are details of contract arrangements between Reclamation and the water user including preconstruction negotiations, interest rates, and reimbursability.

Copies of the 43-page paper are available at the Bureau of Reclamation, Department of the Interior, Washington, D.C. 20240 # # #

A water settling area, softening and filtration plant are often needed in cities. This is the Weymouth plant in LaVerne, Calif.

At Crane Prairie Reservoir

OSPREYS get lake-view home

y GORDON J. FORSYTH, Washington D.C.

THE osprey, a large fish-eating hawk which is rapidly becoming scarce, has picked an ideal ome for itself—a reservoir in northwest Oregon.

Ospreys look like white breasted eagles. They refer nesting in isolated tree tops or on poles 20) 50 feet high, and they favor a lake, river or bay s their front yard. Their habitat at Reclamation's rane Prairie Reservoir suits them fine because ne dam has, for a long time, backed up waters ito an area of lodgepole pine trees.

As part of Deschutes National Forest, the area planned to be the Nation's first management rea to preserve breeding grounds for osprey.

The pine trees in the water died over the years, nd their stark trunks remained standing high bove the water. Then they became 2-story houses ith ospreys occupying the top floor. Meanwhile 1 the basement, not aware that some of them ould be solving the ospreys' meal problems, sh found shelter and food among the underwater nags.

Looking down on the trout or whitefish he wants or lunch, the sharp-eyed osprey plunges feet-rst into the water to clutch his prize.

Man in Yard

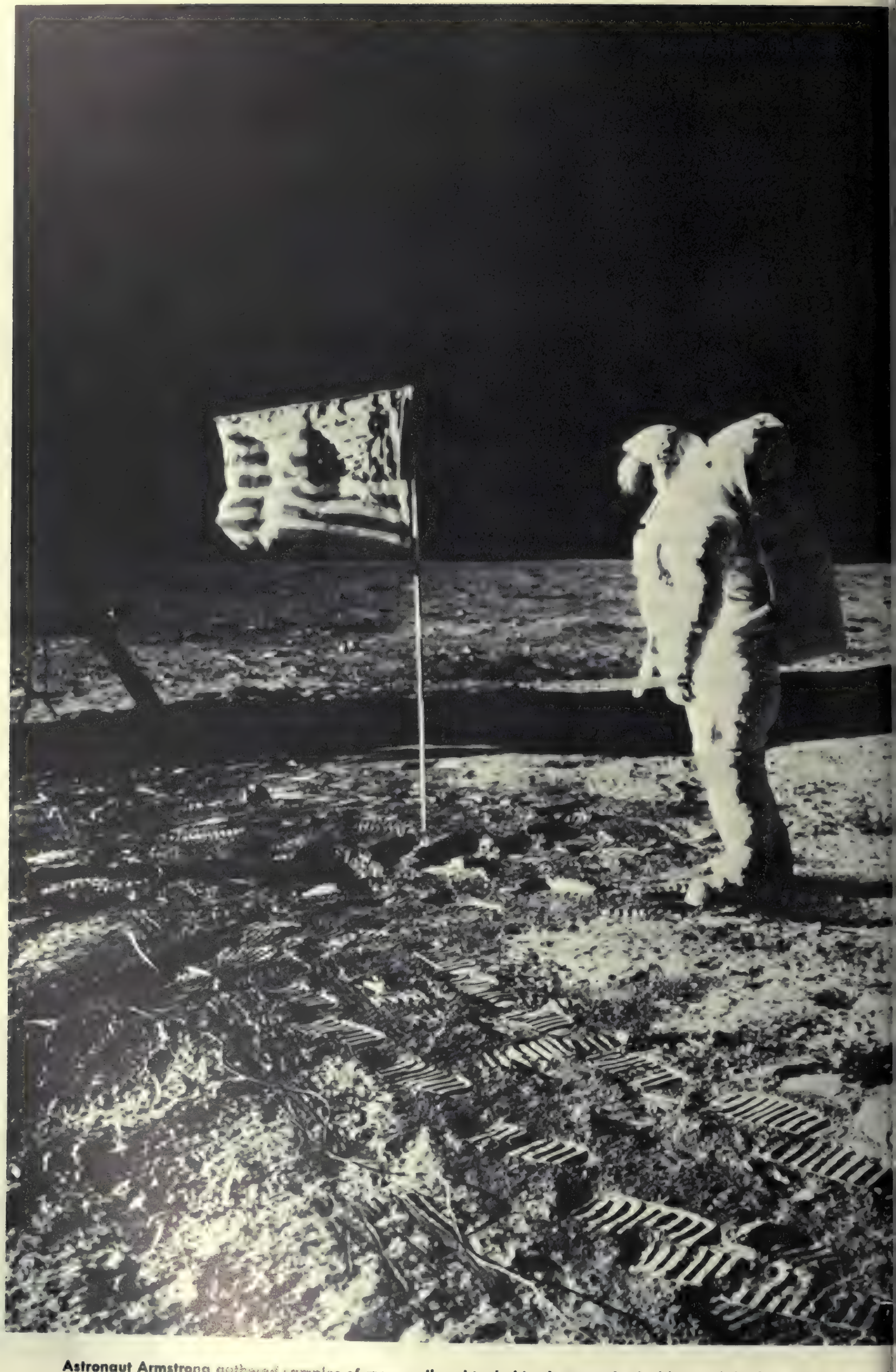
Man also found out about the good fish popula-on and the reservoir is popular for that sport. t is fairly common to see people in this "ghost orest" fishing from motorboats, while a hundred eet away an osprey remains on its nest.

Last summer there were 44 active nests in the rea, all built this year. The nests were new be-ause last winter's heavy snows toppled the struc-ures used previously.

One of the main objectives of the protection plan is to preserve existing tree trunks in the lake and replace toppled ones with artificial nest poles. Discharging firearms, for any reason, will be prohibited in the area during the nesting season from April 1 to September 30.

In addition to fishing, both Crane Prairie and nearby Wickiup Reservoirs provide boating, camping, picnicking, and swimming.

Principal purposes of Crane Prairie Dam and Lake are for water storage on two Reclamation irrigation projects. These are Deschutes project on which irrigated crops valued at $236.8 million have been produced since first reports were made in 1940; and the Arnold project which produced a total of $2.4 million in irrigated crops since first reports in 1951. # # #



Astronaut Armstrong gathered samples of moon soil and took this photograph of Aldrin and the flag. (NASA photo)

Moon Samples Analyzed at Grand Coulee Dam

by W. J. CHASTAIN, Special Services Officer, Grand Coulee, Wash.

THE first moon samples ever brought to earth by man—easily the most widely heralded geologic event in history—will soon, fittingly, be taken to the world's largest mass concrete laboratory for sensitive radiation tests.

This concrete laboratory is deep inside Reclamation's huge Grand Coulee Dam in north-central Washington State.

The precious moon dust and rock was brought back to earth by astronauts Armstrong, Aldrin, and Collins returning from mankind's first moonwalk last July.

A significant portion of the lunar material was scheduled, when this article was written, to be transported to Grand Coulee Dam for the uncommon scientific tests.

As late as 2 years ago, while practically everyone was still associating "men on the moon" with science fiction, Grand Coulee Dam was chosen for the special lunar analyzing. The dam was selected by Battelle Northwest Laboratory, a Division of

This lucite (plastic) container is where the moon samples will be inserted for testing. Liquid mercury shielding is poured into the lucite cylinder, and the end plug holds it in place during the test.

Battelle Memorial Institute which has the responsibility of analyzing the lunar material for radioactive content.

Studies had shown that the natural cosmic-rays are largely filtered out by placing the detector instruments at moderate depths underground enabling scientists to get more accurate readings on material being tested than would be the case on the surface of the ground. Based on this knowledge, Battelle required a laboratory which provided massive cosmic-ray shielding. The lab also would need constant temperature, reliable power source, and the best possible access.

Grand Coulee Dam met these qualifications. Because the laboratory is 360 feet below the crest of the dam, a great amount of solid concrete shielding is above the laboratory. Solid concrete also provides more than 200 feet of horizontal shielding downstream and 40 feet upstream, with additional shielding effected by the upstream reservoir.

Temperature of the lab varies only slightly in summer or winter.

Plenty of Power

Power requirements for the moon analysis are readily available, inasmuch as the dam's two powerplants have 18 generators with the capacity to produce 17 billion kilowatt-hours per year.

An elevator extends down to the level of the laboratory, and a motorized forklift is used to transport heavy materials through a long gallery to the lab areas.

Battelle Northwest made arrangements about 2 years ago with the Power Field Division of the Bureau of Reclamation to test equipment in the dam's inner reaches. Arrangements also were made so that testing would not interfere with normal operations of the dam and powerplant.

Radiation measuring equipment called gamma spectrometry is used for the lunar analyses. A Packard analyzer instrument takes the readings from a radiation detector measuring instrument. Four detector systems can be read simultaneously in the analyzer's memory banks.

The equipment does not require constant attention. The analyzer stores the information received from the counters. A technician can come once or twice each week and transfer this stored information to punch tape which is delivered to a computer in Richland, Wash., 160 miles away. At that location the computer quickly shows the amount of radioactivity which exists in the lunar samples.

As a means of protection from radiation, Battelle decided to build a mercury shield large enough to surround a pair of detectors up to 14 inches in diameter with 4 inches of mercury. The main shield consists of two coaxial lucite cylinders

9 inches long which hold 50 gallons of mercury. Because mercury vapors are deadly, they are vented through an acid scrubber.

Lunar Sandwich

Also in the shield is a pair of 11-inch by 6-inch detectors. The lunar sample to be tested is sandwiched between the two detectors. Around the walls, scientists also added 60 tons of shielding in the form of lead bricks, each 4 inches thick and each weighing 28 pounds.

Among the Battelle Northwest scientists involved in the program are Dr. James H. Kaye, R. E. Connally, H. G. Rieck, Jim Deardorff, John Fager and others concerned with equipment, the reading, and the interpretation of the data collected.

Because of the deep location of the laboratory in the dam, security is not a major problem. Guards from Reclamation's Power Field Division control the main access, and few personnel would have reason to be in the area of the test proceedings. During the time the moon samples are present, Battelle will take more extensive security precautions with all persons.

Radiation tests of the moon samples have been made by NASA at Houston, and in their Ames Laboratory in California. Battelle, under a contract with the National Aeronautics and Space Administration, has made the only other radiation tests at Grand Coulee Dam and Richland, Wash. The equipment used is being provided under the research programs sponsored by the Atomic Energy Commission.

Other Utility

Such galleries as that in which the lab is located serve a variety of purposes in regard to the dam in water control aspects—inspection, drainage, grouting, hoist operation, drum gate operation, for communication cables, and for power cables. Galleries extending from end to end of the dam near the upstream face are located at each 50-foot elevation. One of these galleries is now in use for carrying the 230-kilovolt cable from the right powerplant to the new consolidated power switchyard.

Also for effective and economical use, galleries will be used to lay out the high voltage cable across the dam from the third powerplant to a switchyard above the present consolidated switchyard. These 525-kilovolt cables will be the highest voltage cable system in operation in the world.

Although the first moon samples will be in the radiation laboratory for testing only a short time, the continuing value of the site is through its remaining potential uses in developing and testing even more sophisticated equipment. Scientists who were preparing for the first moon sample 2 years ago or more, are now preparing for other samples from perhaps even other planets. Also 9 more landings on the moon have been authorized.

This means that equipment must be developed and tested to meet the new challenges. But whatever materials may be brought from outer space, the moon coming up over Grand Coulee Dam will have new significance for a long time to come.

# # #

Instruments on this electronic analyzer provide important data.

These before-and-after photographs show typical effectiveness of Reclamation's R&B program on the Milk River Project, Mont.

$54 million invested during first 20 years

Rehabilitation Power on Artery Problems

A FOCUS on "cleanup and rehabilitate" has been increasing around the country during the last few years.

This year, however, the Bureau of Reclamation marks the 20th anniversary of such a program in the West—the Rehabilitation and Betterment Program which was passed by Congress in 1949.

The R&B program had a postwar start. However, more than $54 million has been invested in the effort.

The program enables water users to receive low-cost Government funds to make improvements in their needful water delivery systems which are old, or have been wasting water because of deterioration. It authorizes interest-free funds for doing the work on existing facilities of Federal Reclamation projects.

The term "rehabilitation" refers to restoring the water facilities to their original capacity or condition. Going a step further, "betterment" refers to rebuilding the projects to a first-class physical condition and bettering them with modern engineering and irrigation practices.

Essentially the program is for adding to the capital improvements, rather than one which merely maintains the irrigation system through ordinary maintenance and repair.

An irrigation system which needs complete rehabilitation is, of course, an economic threat to the community it was designed to serve. Often, the community's economy is centered around the vital irrigation project. If the system is in poor condition, the results could mean partial or complete crop losses, reduced incomes, and other far-reaching decadence.

Old Systems Worst

Hardest hit by deterioration at present are irrigation systems which were built more than 40 years ago. There had been little capability to rehabilitate those systems, until recent years, because during the 1930's money was scarce, during World War II there was a manpower shortage, and for a few postwar years a scarcity of many materials was a problem.

Some "artery hardening" equivalents which usually occur are: canals full of silt and weeds, erosion channels, broken concrete sections, high silt

This canal bank betterment is on the Lower Yellowstone Proj. Mont.

evel in pools or reservoirs, gates outmoded, and structures undercut or washed out. Frequently such water delivery systems are being relined or placed in pipe to save water and reduce costs.

There are three ways the improvement efforts may be accomplished by Public Law 335:

One way is by contracts awarded and administered by the Bureau of Reclamation.

The most often used way is through work performance contracts in which the water users' organization is responsible for the work.

Third, is a seldom used way in which employees of the Bureau of Reclamation do the work. In this case, usually the water users' organizations are too small to take on the responsibility of the work.

One of the first water districts to avail itself of the new R&B program was one of Reclamation's earliest constructed projects. This was the Salt River Valley Water Users' Association in Arizona, which began operation in 1903 and undertook R&B in 1950.

Asked for $6 Million

Assisted by Reclamation, the organization developed a 6-year program, and applied for a $6 million loan to cover it. That represented the first phase of an estimated $30 million program to modernize the 242,000-acre project.

Bureau specialists teamed up with water users' officials on a program which would ensure maximum returns for the association's facilities. This included lining and related work on 140 miles of canals, over 800 miles of laterals, and over 300 miles of drain ditches. More than 150 of the project's 251 pumps required overhaul because of lowered groundwater table. Also, water loss records and past seepage test results were studied.

Salt River had another problem, one which is becoming increasingly important at other projects in the West. Suburban areas are expanding rapidly into the boundaries of projects, and demands are increasing that waterways be placed in pipes and covered rather than left open. When open, the arteries create a safety hazard in populated areas and often interfere with road widening plans.

By early 1955, 28 miles of concrete pipeline had been laid and future installations were planned on the Arizona project.

More than 4,400 obsolete wood gates which required excessive maintenance were replaced with rubber-sealed metal gates at all turnout structures. This work also was effective in eliminating leakage at these structures, and much weed growth in the area. Needed repairs were completed on storage dams including Roosevelt Dam, key structure of the system.

What were the benefits from the initial phase of the Salt River program?

A 4-percent decrease in water losses, 40,000 acre-feet, were recorded for the 1950 through 1953 period. With water valued at $5 per acre-foot at the time, this was a savings of $200,000 per year.

Faring Better

Maintenance costs were reduced 2½ percent. Other benefits were improved operations and service for the 7,000 farmers and the 28,000 urban accounts on the project.

The R&B contracts with the Bureau provided for advancement of funds on a quarterly basis, and a new contract was signed each fiscal year of the program. Salt River association forces did the engineering and construction work with inspection and approval by the Bureau.

By June 30, 1950—8 months after enactment—

12 irrigation projects were in the Bureau's Rehabilitation and Betterment Program with loans totaling nearly $3 million.

At one farm on the Tucumcari project in New Mexico, 40 acres of land had been lost when seepage from an adjacent lateral made cultivation impossible. Test wells parallel to the waterway showed a high-water level. Through an R&B the Arch Hurley Conservancy District launched a 5-year program to line a 6,500-foot reach of the lateral with 26,600 square yards of plastic membrane.

Following installation, the test wells were found dry. The 40 acres were restored to cultivation while water losses from seepage were sharply reduced, or eliminated in some places.

Linings at critical reaches of other water conveyance systems throughout the West, made possible by R&B loans, have not only eliminated the dual problems of water loss and water logging of lands but also excessive weed growth.

One in California

Another example of typical R&B benefits was on the Orland Unit Water Users' Association district in northern California. Here much of the 1920 hand-placed lateral lining had deteriorated beyond repair. Water losses were high. Orland district drew plans for relining about 70 miles of the 140-mile system and by 1967, had expended more than $690,000 of R&B funds in their effort.

Three benefits seen early in this effort included reductions in cleaning costs and size of maintenance crews. Also the Orland Unit has been able to save enough water to add one-half an acre-foot more water for a higher yield in crops.

Extensive R&B work is paying dividends for water users in two districts on the Bureau's North Platte project, another veteran of the early 1900's.

The Goshen Irrigation District in eastern Wyoming recently completely placement of about 120 miles of precast concrete pipe in its 315-mile lateral system.

The Gering and Fort Laramie Irrigation District has a similar program for installation of pipe in 109 miles of its 302-mile lateral system. Officials of the latter district estimate that R&B would salvage 10,700 acre-feet of water out of the total 17,700 acre-foot loss. This represents a saving of more than $20,000 a year. The district also expects savings of about $170 a mile in maintenance and operation costs.

Conversion of laterals and other conveyances to underground pipeline systems benefit the landowner in yet another way. The backfilled area which is leveled over the pipe becomes available for productive farm land. In a typical instance there were 2.4 acres per mile of pipeline backfill.

Also Weeds

Also, aquatic weeds are kept under control. They account for losses through transpiration of an estimated 15 million acre-feet of water annually in western irrigation systems.

R&B programs frequently benefit irrigation features other than those on the surface of the land. For example, part of the 60-year-old, 5.8-mile Gunnison water tunnel in Colorado is being relined at a cost of $989,870. This work is scheduled for completion in 1970. The tunnel is the vital link between the Gunnison River diversion facilities and the valley where, together with supplies from the Uncompahgre River, water assures the continued successful operation of the 76,000-acre Uncompahgre Project.

Benefits which have accrued to about 30 older Reclamation projects include their improved operation, water conservation, more land utilization, and maintenance cost reduction.

Returns on the $54 million investment is worthwhile, and it seems there is a cure for one type of "hardening of arteries." # # #

The above reproduction of a postage stamp was issued as part of the 1969 commemoration of John Wesley Powell's important accomplishments including establishing the first factual basis for reclamation of water and land in the Western United States, and completing the daring exploration of the Green and Colorado Rivers.

Shadow Mountain Lake—high in the Rockies.

High values at three Reclamation lakes

Recreation Windfall in Scenic Colorado

by H. E. MEW, JR. and J. GORDON MILLIKEN

ONCE a man-made lake is completed for recreation nowadays, it is amazing how great an impact it can have on an area. People flock to the reservoir, and recreation spending takes on significance.

In recreation spending, three reservoirs of Reclamation's Colorado-Big Thompson water resources project generated a cash flow of nearly $5 million last year.

Those lakes are Granby and Shadow Mountain located about 2 miles from each other in a spectacular mountain area of Colorado, and Horsetooth Lake in a barren foothills area in another part of the project.

The two mountain lakes—Granby and Shadow Mountain—are west of the Continental Divide at more than 8,300 feet elevation. The foothills lake on the eastern side—Horsetooth—is at 5,400 feet. A water tunnel through the Rocky Mountains connects the water storage facilities on the west slope to those on the east slope.

The study noting the economic and social impact of these 3 reservoirs was recently completed for the Bureau of Reclamation by the University of Denver's Denver Research Institute. Built by Reclamation during the 1940's, the Colorado-Big Thompson project facilities transport water from the Colorado River across the Continental Divide and delivers it for extensive irrigation and municipal and industrial uses in northeastern Colorado.

From exhaustive studies and interviews, DRI economists estimated the 1968 impact of recreationist-visitors at Shadow Mountain-Granby at $3,396,000 and Horsetooth Reservoir at $1,486,000.

$532,000 in Boats

Included in these figures are boat sales estimated to be $532,000 at Shadow Mountain-Granby and $1,260,000 at Horsetooth Reservoir. Almost three-fourths of the total investment in boats and boating equipment was represented by purchases outside the impact areas adjacent to the reservoirs.

Magnitude of the economic growth taking place near Horsetooth Reservoir is indicated by the fact that estimated 1967 property tax revenue from the area adjacent to the reservoir was $175,000 while the cumulative tax loss during the period from 1946 to 1968 from reservoir rights-of-way removed from tax rolls amounted to only $54,000.

The study reports a sizeable increase in net land values, investment in recreation facilities, and other improvements of $4.84 million within the impact area at Shadow Mountain-Granby. The comparable figure for increased investments of this type at Horsetooth Reservoir is $3.29 million.

Horsetooth Reservoir—had $1,486,000 in recreation spending.

DRI interviewers found that Coloradans comprise 46 percent of the summer recreation population at mountainous Shadow Mountain-Granby, and 95 percent of the visitors to Horsetooth. Of the Shadow Mountain-Granby recreationists, 58 percent reported family incomes of more than $10,000 per year, while 43 percent of the Horsetooth visitors indicated salaries in that range.

People From Denver

The 220-mile, 1-day trip to and from Shadow Mountain-Granby is a favorite for people from the Denver Metropolitan area. They boat, fish, swim, horseback ride, or sightsee. The highway takes them through Rocky Mountain National Park, includes Estes Park and Grand Lake, crosses the Continental Divide twice, and offers views of snow-capped peaks and water along 7 miles of reservoir shoreline. They can camp near the lake or stay in a motel near the shore.

Horsetooth Reservoir is about 70 miles north of Denver and 5 miles from Fort Collins. While this area offers different scenic views than the other area in the mountains, no major highways pass by it, and few out-of-state tourists utilize its facilities.

The area around this body of water has become an important relaxation area for residents of rapidly growing Fort Collins. The reservoir is accessible year-around and during most months, many people of retirement age spend part of the day fishing and sightseeing.

Because warmer weather and lower elevation (5,400 feet) prevail at Horsetooth, the water is relatively warm and allows swimming 4 or 5 months of the year.

At Shadow Mountain and Granby however, the water is colder and swimming is desirable only for about two months during the year. Because part of the highway, Trail Ridge Road at over 10,000 feet, is closed during winter (roughly from late October to May) only a few recreationists, primarily ice fishermen, visit these two lakes during this period.

For a population whose unity and driving force years ago was to bring an irrigation project into being for their dry but fertile lands, the water based recreation bonus has turned out to be an unexpected and pleasing windfall for northern Colorado. # # #

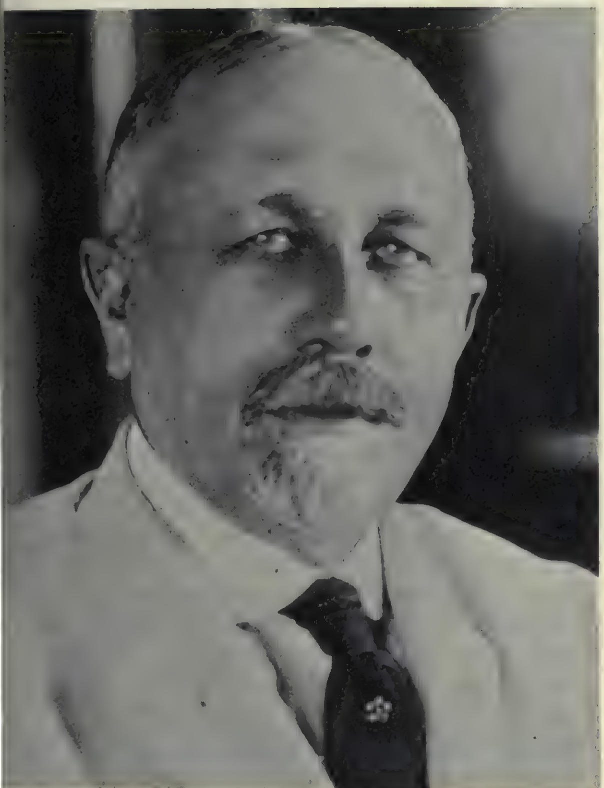
(*Author Mr. Mew is Research Engineer and Dr. Milliken is Research Economist in the Denver Research Institute of the University of Denver. Summarized in this article, their 206 page technical report is entitled: "Economic and Social Impact of Recreation at Reclamation Reservoirs," and it is available at $6 each from the University of Denver, Denver, Colo. 80210.*)

Lake Granby—excellent for recreation.

Made irrrigation Nebraska's foremost issue in 1891

WILLIAM E. SMYTHE: Irrigation Crusader

by MARTIN E. CARLSON



William E. Smythe 1861–1922.

IRRIGATION began in the arid regions of the United States apart from any type of orga-ized promotion. But in 1880 the first stages of the rrigation movement appeared as a result of John Vesley Powell's reports of his government surveys n which he urged legislation to encourage the ractice.

A unique feature of the irrigation movement is hat among the most zealous advocates of irriga-ion were Easterners who for various reasons be-ome interested in its promotion. William E. Smythe was an outstanding leader of this group. This paper covers only the years from 1890 hrough 1895, placing major emphasis upon his work in Nebraska where he began his promotion of irrigation.

Journalist, author, and irrigation expert, Smythe was born at Worcester, Mass., on December 24, 1861. He came to the West in 1888 and settled at Kearney, Nebr., where he published a daily newspaper, the *Kearney Enterprise*, until 1890 when he accepted a position as editorial assistant on the *Omaha Bee*. A series of 7 articles on the subject of irrigation which he wrote for the *Bee* in January and February, 1891, attracted widespread attention and led to the organization of a popular movement to obtain irrigation laws and to interest farmers and capitalists in ditch building. Smythe stated that within three months he had succeeded in making irrigation the foremost issue in Nebraska.

No Public Support

Although several irrigation canals had been built in the State during 1880's, especially in the North Platte Valley, irrigation had not yet gained general public recognition and support. Neither was there popular literature to bring the matter

Many crops under irrigation in Nebraska look as productive as this.

to the attention of the masses. Such was the situation when the Great Plains experienced the drouth of 1890, ". . . a calamity so deep and widespread that it staggered even the optimism of the West."

As a consequence, Smythe said, "The psychological moment had come for the rise of a new cause which should take hold of the popular heart and go on, by a process of gradual unfoldment until it became perhaps the greatest constructive movement of its time."

During the summer of 1889, Smythe had traveled in New Mexico and California, where he saw irrigation being practiced. When the drouth struck Nebraska a year later, the thought occurred to him that irrigation would be a good thing for the Nebraska plains, where "men were shooting their horses and abandoning their farms" within sight of fine streams. When the editor of the *Omaha Bee* directed him to write editorials asking for money, food, and seed for the drouth sufferers, Smythe obtained permission to supplement these articles with a series of papers dealing with irrigation. He later stated that writing these articles changed his life completely.

Taken the Cross

In commenting on this assignment in his book *The Conquest of Arid America*, he said: " . . . I had taken the cross of a new crusade. To my mind, irrigation seemed the biggest thing in the world. It was not merely a matter of ditches and acres, but a philosophy, a religion, and a programme of practical statemanship rolled into one . . . I was deeply impressed with the magnitude of the work that had fallen to my hand and knew that I must cut loose from all other interests and endeavor to rouse the nation to a realizing sense of its duty and opportunity."

To Smythe irrigation was not only the best method of farming, but perhaps even more important, it would lead to the rise of new institutions and social and economic reforms. When he started out upon his irrigation work in Nebraska, he thought of the ditch "only as an insurance policy upon crops." Later, however, he thought of irrigation as "the great basic fact in a new and wonderful civilization"—the salvation of our institutions, the mighty potentiality which was to confer upon "millions of men the blessing of a free home." In arid America, there would evolve the best and highest conditions of living that humanity had ever known.

Smythe believed that irrigation would compel the adoption of the small-farm unit. As the result of the absorption of great areas by syndicates and corporations, Smythe feared the nation was treading on dangerous ground unless a new bulwark for liberty in the form of a great class of small landed proprietors was created. This could be done only by the reclamation of the arid domain and the division of the semiarid lands into small farms. Maintaining that irrigation as a national policy meant "a new birth of freedom," Smythe said:

"Tell the people of Nebraska that we are going to make homes for millions of men; that in these homes irrigation shall guarantee industrial independence and the small-farm unit a reasonable degree of human equality . . . the densely populated agricultural districts of the new Nebraska will have all the advantages of town life and few of its evils, all the charm of country life without its present loneliness. Nebraska's best days are before her. The historian will record them as the irrigation era." (*Nebraska State Journal*, Sept. 3, 1894).

He Promoted

In his enthusiasm, Smythe gave little consideration to the economic factors involved in creating these new farms and the difficult problems to be overcome. This paper, however, presents his work as a promoter of irrigation, rather than his shortcomings as an economist.

Smythe believed that although reclamation and the settlement of the arid domain must always remain the problem of the West, there was one point where the question came in direct contact with national thought and demanded settlement by national legislation. The West was to be conquered in the interest of all the people, and thus it became a question of national interest to determine upon what terms these arid lands should pass from the government. It was his opinion that the arid lands must eventually pass to the States because the streams were already the property of the States, and it was an absurd condition that gave ownership of the water to one authority and that of the land to another. Both should be under one comprehensive policy.

Smythe believed that a feasible plan was to have the governors of the various States appoint commissions, charged with the duty of making comprehensive studies of the whole question. The reports of these commissions should be assimilated by a representative irrigation congress and then be blended into one harmonious measure which could be urged upon the Nation by the unanimous voice of the West.

Such a measure should provide a method by which lands could be reclaimed by private enterprise, under proper safeguards and regulations, and also provide a method by which public ownership of canals, reservoirs, and other works could be

Wornout wagons were not needed when irrigation brought better times.

realized when the people so preferred. It should be made sure that genuine settlers should acquire the lands without paying unfair tribute to Eastern capital that made their reclamation possible.

All Ramifications

In his series of articles in the *Omaha Bee* in 1891, it was his purpose to consider the subject in all its ramifications—the existing need; the benefits irrigation promised; the progress that had already been made; the sources of water supply; the various methods of distribution; the aid needed from State and national governments; the cost of constructing systems; how they were to be paid for, and the expense to the consumer.

His intention was to furnish first a complete exposition of the subject, then to arouse and center the attention of the State upon the matter of irrigation and finally, by these means to interest capital and carry the grand undertaking to success.

The question of the water supply for the arid regions was not then a matter of anxiety to the friends of the irrigation movement, though a few questioned the adequacy of the water resources. In support of his belief that the water supply was ample to meet the State's need for irrigation, Smythe cited the testimony of Professor Lewis E. Hicks of the geological department at the University of Nebraska.

For 5 years, Hicks had been sampling the water and ascertaining its extent in western Nebraska and had just investigated the soil and water supply of the southwestern section under the auspices of the Federal Government. He had carefully examined the Republican River and stated that the surface water was usually sufficient to irrigate 100,000 acres, while the underflow could furnish water for at least 1 million acres. Professor Hicks stated that many canyons could be dammed up as storage basins for a vast amount of water which then ran almost entirely to waste.

Federal

In planning for irrigation in Nebraska, it was important to know how much or how little help was to be expected from the Federal Government. It was Smythe's opinion that all the government could do was to mark out general lines on which the plan could be made to succeed, and then private enterprise and capital must do the rest.

The great difficulty had been to convince capitalists that money could be invested safely in these undertakings. If an expert government engineer reported that a certain amount of money could construct a ditch, water a certain number of acres, and pay a certain percent as dividends on the money invested, private means could be secured to promote the work.

Congress had appropriated funds for making preliminary surveys for testing the underflow and the extent of the water supply. In addition, the settlers in western Nebraska asked only that the national government transfer the arid public lands to the control of the States, and enact legislation to prevent the monopoly of water rights by corporations. Smythe believed that the States rather than the general goverment, should assume the major responsibility for the reclamation of arid lands.

He later changed his position and favored a program of reclamation by the Federal Government.

"The way to the success of the irrigation movement in Nebraska lies through the statute book," Smythe declared. A revision of the scanty laws in existence and the addition of a comprehensive scheme of legislation were necessary. Until 1889, Nebraska had no laws bearing on the subject of irrigation. The legislature of that year passed a law which dealt only with water rights and the right-of-way for ditches. It was defective in some respects and as a whole inadequate for a systematic effort to develop irrigation in western Nebraska.

Got a Convention

An irrigation convention at McCook, which was called as a result of Smythe's promotion efforts, constituted the formal inauguration of a campaign to promote a system of irrigation in Nebraska. It showed that the western part of the State strongly desired a State engineer, the division of the State into water districts, and the preparation of a complete system of maps, showing the water sheds and the streams.

Extra delicious pumpkin pies result from irrigated Nebraska crops.

Smythe said that when these laws had been secured, the movement must then undertake to interest capital in these enterprises. It was decided at the McCook meeting to holding a similar convention at Sidney followed by a great mass meeting at Lincoln to endorse a bill to be drafted for presentation to the legislature.

Unfortunately, the irrigation code which had been approved at the State irrigation convention at Lincoln in 1891 was not adopted by the legislature until 1895. When Smythe was on his way to attend the Third Irrigation Congress at Denver, he stopped at Omaha on August 30, 1894, and was interviewed by a representative of the Lincoln *State Journal.*

In speaking about the prospects of further development of irrigation in Nebraska, he pointed out that what had already been done in the valleys of the major rivers would mark the limitations of large undertakings in the State. But when all the land that the large projects could water was utilized, the State would then enter upon what, in his judgment, would be the distinctive phase of the Nebraska irrigation industry. This would be the development of small individual plants using pumps, windmills, and other mechanical appliances.

Smythe Predicted

Probably four-fifths of the land irrigated in the State 10 years later would be watered in this manner, Smythe predicted. He asserted that the owner of a small plant, adequate to his needs, was enviably independent—independent of the drouth, the butcher and grocer, of hired help, and last and best, independent of the water company.

"Show me a man," said Smythe, "who irrigates 20 or 40 acres of your rich Nebraska soil by means of his own plant and I will show you a man who knows no master but God."

After resigning his position with the *Bee* in 1891, Smythe left Nebraska and continued on a national scale his crusade for the reclamation of the West and also the colonization of the sparsely settled arid and semiarid regions. He expressed his views on these subjects in the columns of the *Irrigation Age*, which he founded and edited from 1891 to 1896. He started the magazine in Denver but later removed its office to Salt Lake City, where he devoted his efforts exclusively to the cause of irrigation.

Smythe's own account of his activities and his fight for a national program of reclamation is found in his book, *The Conquest of Arid America.* In evaluating his work, Walter Prescott Webb in *The Great Plains* says: "No one can read his book without realizing that he went at his task with the fervor of an evangelist and with that exaggerated emphasis of its importance which seems essential in all propaganda. . . . He played upon emotion, imagination, pecuniary desire, and patriotism, and to him irrigation became the one means by which arid America could be conquered."

At the State irrigation convention in Lincoln, in February, 1891, Smythe was made chairman of a committee to arrange for the first National Irrigation Congress, which met in Salt Lake City, September 15, 1891. Smythe founded this organization for the purpose of bringing together the various groups and elements that were interested in irrigation in order to work out a program which would have sufficient support to be adopted.

Resolution Adopted

The first Irrigation Congress was called in the interests of the movement to secure the cession of arid land to the States and territories. Resolutions asking that this be done were adopted unanimously.

As secretary of the Irrigation Congress for the years 1891 and 1893 and as its president from 1893 to 1895, Smythe lectured extensively on the subject of irrigation. He addressed public meetings in various large cities, including Chicago, New York, Washington, and Boston, and interested eminent men throughout the country in the settlement and development of arid lands.

Smythe was undoubtedly the most influential advocate of irrigation in Nebraska during this period. In general, the views expressed by the press and other supporters of irrigation reflected those of Smythe. The subject received widespread coverage by the daily newspapers and also by the local papers in the areas where irrigation was practiced. The space given to its discussion reached a peak during the years 1894 and 1895 and then gradually declined to the end of the decade.

The second session of the Irrigation Congress held in Los Angeles in October, 1893, represented the best thought and experience bearing on the irrigation problem. Probably the most important outcome of the meeting resulted from a speech by John Wesley Powell in which he stated that even by full development of the water resources, there would not be enough to irrigate more than a small portion of the arid land.

Because of his unpopular views, Powell was read out of the irrigation movement and Smythe became its most prominent leader. When a permanent member-at-large was elected, Smythe was chosen as the one who was "more preeminently connected with irrigation than any other man in the country."

One of the problems in the expansion of irrigation was that of attracting farmers to settle in the arid regions. Having studied the Utah and Greeley settlements, Smythe determined to use the colony system to bring settlers from the East. He devoted so much time and energy to colonization in 1894 and 1895 that it cost him the leadership in the general irrigation movement.

He Opened the Fourth

Although he delivered the opening address at the Fourth Irrigation Congress at Albuquerque in 1895, he took little further part in the proceedings, and his perennial position as chairman of its executive committee was given to E. R. Moses of Kansas. That same year he also lost the editorship and then control of his magazine, the *Irrigation Age*. No further articles by Smythe, or mention of him appeared in the periodical. The heyday of his career as irrigation crusader was over.

Wallace Stegner in his book, *Beyond the Hundredth Meridian*, says this in tribute to Smythe: "His persistent publicizing of irrigation problems, and his organization of arid-belt farmers into a politically coherent group, made him the single most influential figure, with the exception of Major Powell, in the early years of reclamation."

At the end of his career as a leader of the irrigation movement Smythe could say with considerable truth that he had carried the "cross of a new crusade," he had helped rouse the Nation to "a realizing sense of its duty and opportunity," and in this task he had found a work to which he gave his "heart and soul with all a young man's enthusiasm." # # #

(*We are grateful to Martin E. Carlson, professor of social science at Kearney State College, Kearney, Nebr., for use of this article. It was presented by Dr. Martin as a paper at the Western History Association meeting in 1966, and has been printed in the* Journal of the West *with excellent source footnotes.*)

Water for Another Family

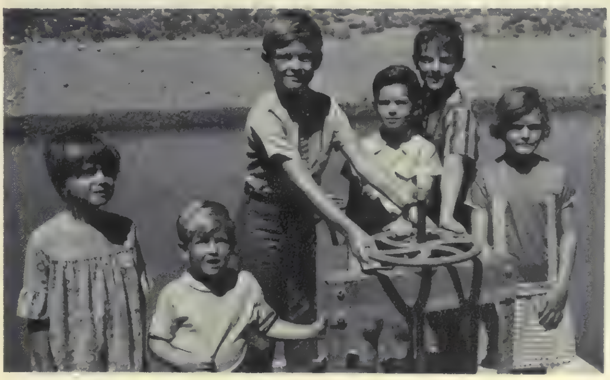
Turn the handwheel and water will flow on their new farm—the 6 ArDean Bird youngsters know that. And if these children wish, while growing up, they can help take care of animals and raise many good crops.

First irrigation ceremonies, like the one attended by Mr. and Mrs. Bird and their children, plus about 100 others last July 30, have been held frequently in years past on Reclamation's Columbia Basin project in Washington. The celebrations still generate excitement in highlighting the future potential for new farmers, businesses and communities.

Following the new opening of fertile land for water, which includes more than 50,000 acres on the Wahluke Slope, Block 25, irrigated farms will spring up in the years ahead—same as farms and communities did on half-a-million acres in other parts of the project since it went into operation 21 years ago.

Placing significance in the event were participating officials of the nearby towns of Pasco and Mattawa, Chambers of Commerce, the South Columbia Irrigation District, the lovely Miss Washington State, officials of the State and a railroad. Representatives of news media from distant locations were present. Regional Director H. T. Nelson of the Bureau of Reclamation, Boise, Idaho, was one of the speakers. # # #

Young members of the Bird family to live on the new project farm are from left, Laurel, Blake, Allen, Blair, Keith, and Paula.



WATER Quiz

[1] Can you guess the length and weight of this Mackinaw trout caught through ice at Jackson Lake, Wyo.?

a. 37″ long, 23 pounds

b. 23″ long, 37 pounds

[2] Of the 36.9 million acres of land irrigated in the United States (1964), what percentage of it is in the 17 Western States?

a. 90%

b. 82%

c. 60%

[3] What is the importance of leaving certain tree stumps in new reservoirs?

[4] What European royalty has visited Glen Canyon Dam and Lake Powell?

[5] This is the new Morrow Point Dam in Colorado. Is power generated here; if so, where is the powerhouse?

ANSWERS:

1.—a. 37″ long, 23 pounds; 2.—a. 90%; 3.—Parts of trees serve as natural habitat for certain kinds of fish and birds; 4.—Princess Margaret and Earl of Snowdon (England); 5.—Yes, its underground powerplant is in the right canyon wall.)

Class on family;
how they enjoy it!

Unique Course for Collbran Corps

by ORA C. DREHER, VISTA
Civilian Conservation Center
Collbran, Colo.

Mrs. Dreher, author of this article, working in classroom activity.

WHAT goes on here? one wonders as he views bulletin boards in the hallway: "The Kind of Girl We Wish to Date," is printed on a display. Pictures of attractive girls of many races embellish the bulletin board and increase interest in the subject.

"Am I Coming Up to Her?" is in a flare of gay lettering. Near such slogans are Job Corpsmen quotations describing the girl in their minds.

Slogans and illustrations on another display also stimulate thought by the young men. They are in the hall of the Education Department of the Collbran Civilian Conservation Center. There is increasing interest in: "The Kind of Home We Wish To Establish," "Ideals for a Future Home," "Am I Working Hard Enough?"

The Corpsmen teacher says she knows the young men have high ideals. They just need education and good jobs.

This family living teaching also includes studies on the 10 commandments to prevent alcoholism. The study on drug abuse included the film: "Narcotics—Pit of Despair."

The Collbran Corpsmen are deeply moved as they learn and are making firm resolves for their future lives.

Meanwhile, principal work program for the young men at the Bureau of Reclamation's Collbran Center during the past few months has been construction of campgrounds, recreation facilities and roads in the area of Vega Reservoir on Reclamation's Collbran irrigation project in west central Colorado.

Foolish?

But back to the classroom. The thinking of one corpsman, regarding the family living lessons, was that making out budgets, keeping accounts, and learning how to iron and press trousers were foolish lessons. But when he got out on a job and in his own apartment, he wrote back that he wanted his family living teacher thanked for the practical help he had received.

How they enjoy the units, "Making the Grade as Dad" and "The Modern Father Helps with Child Care." "Teenage Marriage" opens their eyes. One corpsman said, "We get to see things in a way we never thought of before."

"I don't want my sister to get married until she is old enough and mature enough, and I will wait until I have a good job and a good savings account. Too, I want to marry a girl who has good sense about money, likes children, and knows how to help make a home."

18 Months' Duration

This unique course in health and family living has been in progress at the Collbran Job Corps of the past 18 months. It was initiated and is carried out by a VISTA who has taught family living to high school and college girls, adults, and underprivileged Negro boys and girls.

It is a continuous challenge to the teacher to make the activities practical by bringing them to the level of the corpsmen, their needs, their educational development, and their interests.

The purpose of the course is to help the corpsmen grow in understanding and maturity so that they will become good husbands and fathers and contributing members of the community in which they establish their homes.

With flexibility as the key, some of the variety of teaching techniques used are: (1) Role playing—spontaneous reactions to one another in problem situations, some of which are suggested by corpsmen from their life experiences; (2) Assigned original skits; (3) Demonstrations and practice; (4) Friendly, helpful accepting atmos-

phere in classroom; (5) Films; (6) Check lists and questionnaires to get information about knowledge, experiences, and interests.

Attitudes

No matter whether the unit is related to health or to happy family living, good role play can be devised, and it also not only brings out attitudes but helps corpsmen in self-expression.

One of many roles is entitled, "How Will Father's Bonus Be Invested?" Instructions to each player are given privately so they react to one another. To father: You have just received a $150 bonus, and you feel that you should give the family the opportunity to have a part in deciding how the money will be spent; but you have your mind made up. You will buy the "beaut" second hand car you have seen.

Instructions to mother: You plead for new screens. Every screen in the house flaps in the breeze. You can't keep out flies and serve sanitary meals without screens.

Instructions to teenage brother and sister: You want your father's bonus to be used as a down payment on a color TV.

The young men here are discussing the educational bulletin board.

At the awards assembly in September, certificates were to be presented to the corpsmen who have completed this course. How a teacher would like to look into the future and view these corpsmen's home life! # # #

NEWS BRIEFS

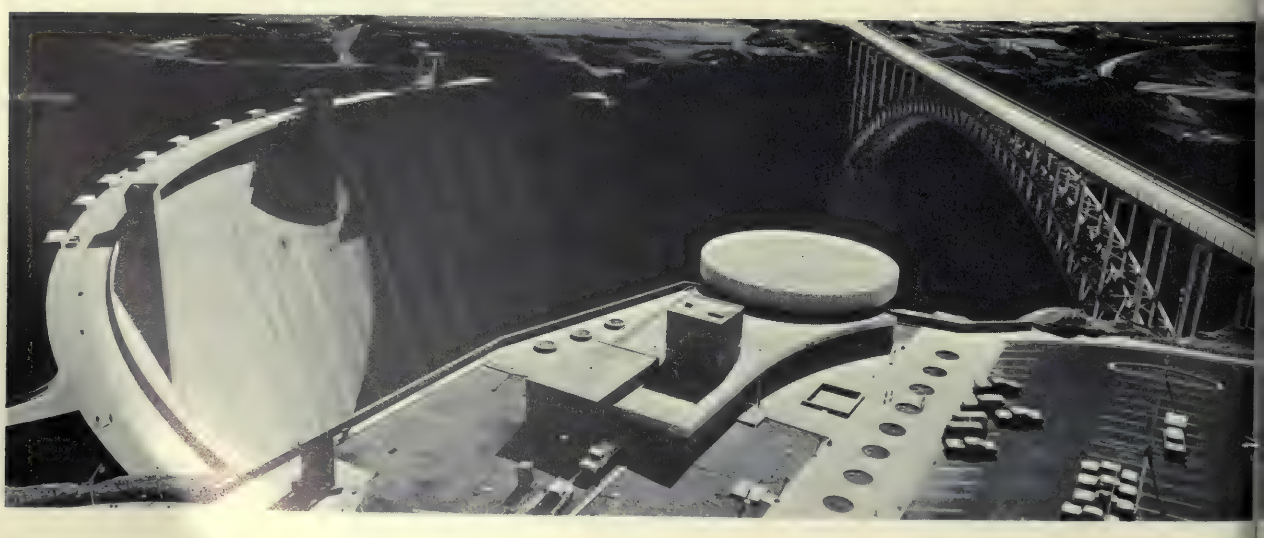
The spectacular Glen Canyon Visitor Center, on the high canyon rim overlooking Glen Canyon Dam, Colorado River, and Lake Powell was opened to the public last April.

Located adjacent to U.S. 89 and Glen Canyon Bridge, the Visitor Center serves to orient the visiting public to interesting sights and recreation in the area.

Highlighted in the center of the exhibit rotunda is an accurate and detailed relief model of Lake Powell and surrounding terrain. Model maker Bob Miller of Westminster, Colo., spent 2 years working on the model. The model gives visitors some idea of the magnitude of the lake, the variety of landforms, and the range of brilliant colors to be seen. It recreates the impression made upon geologist Clarence Dutton in 1880, who called the Glen Canyon country "a superlative desert." . . .

The name of the water tunnel the Bureau of

Spectacular viewing is in store from the new visitor center.



Reclamation is boring through the Continental Divide on the Fryingpan-Arkansas project, Colo., was changed last August from "Divide Tunnel" to "Charles H. Boustead Tunnel."

The underground waterway will convey water from Colorado River tributaries on the western slope of the Rocky Mountains through the Divide for use in the water-short Arkansas River Basin on the eastern slope.

Renaming is in recognition of Mr. Boustead's long and dedicated service on behalf of the multiple-purpose Reclamation project both as president of the Water Development Association, which pioneered the effort to obtain authorization for the project, and as general manager of the district.

The 5.4-mile-long tunnel is scheduled for completion in 1974. . . .

Five contracts totaling nearly $6 million for 4 years of advance research and field experimentation in support of Reclamation's "Project Skywater," were awarded last July.

The contractors and contract amounts are: South Dakota School of Mines and Technology, Rapid City—$2,280,000; University of Wyoming, Laramie—$2,000,000; New Mexico State University, Las Cruces—$635,000; Montana State University, Bozeman—$595,000; and Colorado State University, Fort Collins—$107,815.

The Montana contract extends through June 30, 1972, and the other four through June 30, 1973. . . .

Reclamation is designing a first-of-its-kind deck truss bridge 2,428 feet long, supported by slender concrete piers 403 feet high, to carry vehicular traffic over the new lake that will be formed behind Auburn Dam on the American River in northern California.

The graceful structure is the highest bridge of its type ever designed by the Bureau, and ranks as one of the Nation's longer deck truss spans. Deck of the new bridge will be some 700 feet above the present river level.

This bridge will replace a Placer County bridge which now spans the North Fork of the American River near the town of Auburn. . . .

Undergrounding of 4,500 feet of electric cable from the base of Reclamation's San Luis Dam to the administration building was completed last August by Ferrero Electric of Los Banos, Calif.

The cable, which furnished power supply to piezometer terminal wells and seismograph stations near the dam, replaces overhead wires and poles.

The job, which took about 1½ weeks, was bid for $8,590.

The trench in which the cable was buried is a small one, just 18 inches deep. The piezometer measures the water pour pressure in the foundation under the dam. Earth vibrations are measured by the seismograph. . . .

The *Snake River News* newspaper at Reclamation's Marsing Job Corps Center was presented the first place award in the National 1969 Corpsman Newspaper Contest at ceremonies in Washington D.C. last July. Mrs. Helen Branson, Editorial Adviser, also received a special award for outstanding adviser efforts on the *Snake River News*.

With the competition including all urban and conservation Job Corps Centers in the Nation, the third highest award in the contest went to another Reclamation Center newspaper, the *Columbian Echo* of the Columbia Basin Center in Washington.

On hand to receive the first place award were Mrs. Branson and Delbert Wright who is Corpsman Editor-in-Chief. Both are physically handicapped. Other Job Corps staff and officials, and Congressmen also were present at the award ceremonies. # # #

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)

IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, De[illegible] Center
Denver, [illegible]

BOOKSHELF
for water users

Research Report

Latest in the Bureau's series of Water Resources Technical Publications, the illustrated research report No. 16, entitled: "Structural Model Tests of Arch Dams—Glen Canyon and Morrow Point Dams," describes specific uses of structural dam models and their materials, construction, loading, and testing.

Irrigation Improvement

A technical booklet of interest to irrigationists is entitled: "Irrigation System Evaluation and Improvement." It is by John L. Merriam, Professor, Agricultural Engineering, California State Polytechnic College.

This 68-page publication is available from Blake Printing and Publishing, 1415 Monterey St., San Luis Obispo, Calif. 93401, for 75 cents.

Evaporation Reduction Film

A new 16 mm. technical motion picture, "Water Conservation Through Evaporation Reduction," has been added to the Bureau of Reclamation's film library.

The film summarizes the methods employed in suppression of evaporation from the surface of reservoirs, materials used, means of applying the materials, and evaluation of results obtained. Aim of the film is to instruct technical students, engineering groups, agencies concerned with reservoir operations, and other interested organizations in techniques for reducing the loss of water supplies from reservoirs through evaporation to the atmosphere.

The 27-minute sound, full-color film is available for loan on request to the Office of Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colo. 80225.

There are modern high-powered engines which heat up and the "radiator" of this one sorely needed a drink. The water-cooled racer gets a filling from the city water supply, Sacramento, Calif.

585 billion gallons served in 1968

CITY WATER SETS RECORDS

OVER 585 billion gallons of water for more than 14 million city people and industry in Western United States were served during 1968 by Bureau of Reclamation projects.

According to Assistant Secretary of the Interior for Water and Power James R. Smith, urban deliveries increased 6.1 percent over the 1967 figure—establishing a new record for water deliveries of this type from Reclamation projects—and have increased some 140 percent in the past decade.

Said Smith, "Growth in the West has always depended heavily on water development. At first the primary need was for irrigation water. Now we are feeling the demand for city water. It's really a sign of the success of previous water projects which provided the basis for Western development."

Population growth has been rapid in the West and 15 of today's 25 fastest growing population centers are in the Western-Reclamation-States.

In addition to municipal and industrial deliveries, Reclamation projects delivered some 33 billion gallons of water for other nonagricultural purposes.

On the average, Reclamation M&I deliveries accounted for about 60 percent of the needs of the people served—about 115 gallons per-day-per-person.

Three Reclamation projects reported their first M&I deliveries during 1968.

Some 8.1 million gallons for 3,800 residents of Beloit, Kans., were provided by the Glen Elder Unit of the Missouri River Basin Project. The city pumps water from the Solomon River about 12 miles below Glen Elder Dam. Construction of the dam was necessary to stabilize the flow of the river, thus providing Beloit with a dependable, year-round water supply.

Other projects making first reports—Spokane Valley Project, Washington, and the Glen Canyon Unit, Arizona—delivered about 754 million gallons to some 1,500 people.

In addition to the regular Reclamation projects, the Eastern Municipal Water District, Calif., a Small Reclamation Loan Project, delivered 409 million gallons to 7,340 people.

Sharp increases in M&I service occurred during 1968 on 2 projects, both in only their second year of service. The Canadian River Project delivered nearly 9.6 billion gallons of water to about 410,000 people in 11 northwest Texas cities, 13 times as much water to 27 percent more people than in 1967.

In Oklahoma, the Arbuckle Project serving residents of Davis, Sulphur and Wynnwood, brought 600 million gallons of water to 5,100 people—four times as much water to 13 times as many people as in 1967.

The report containing Reclamation's water-use figures for 1968 became available this fall from the Washington, D.C., headquarters. # # #

INDEX TO RECLAMATION ERA

Volumes 53, 54, 55

1967–69

A

B

C

T

U

V

W

Y

U.S. GOVERNMENT PRINTING OFFICE: 1969 O—359-093

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Decription of Work or Material	Contractor's Name and Address	Contract Amount
DS-6662R	Columbia Basin, Wash.	Aug. 1	Furnishing and installing three 525-kv high- or medium-pressure oil cable systems for Grand Coulee third powerplant.	British Insulated, Callender's Cables, Ltd., Belvedere, Kent, England.	$2,943,000
DC-6756	Missouri River Basin, N. Dak.	July 22	Construction of stage 02 additions to Forman substation.	United Power, Contractors and Engineers, Inc., Seattle, Wash.	405,805
DS-6759	Missouri River Basin, Colo.	Aug. 6	One mobile autotransformer and one mobile interrupter switch unit for Region 7.	Westinghouse Electric Corp., Denver, Colo.	186,508
DC-6760	Central Utah, Utah	July 16	Relocation of 2.2 miles of Strawberry River road	Whiting and Haymond Construction Co., Springville, Utah.	334,007
DC-6765	Pacific Northwest-Pacific Southwest Intertie, Calif.	Aug. 14	Furnishing and installing counterpoise grounding for Malin-Round Mountain 500-kv transmission line No. 1.	Seek, Inc., Roseberg, Ore.	142,500
DC-6766	Teton Basin, Idaho	Aug. 11	Pilot grouting for Teton dam	McCabe Brothers, Inc., Idaho Falls, Idaho.	107,688
100C-1064	Columbia Basin, Wash.	Aug. 7	Construction of 21 miles of buried pipe drains, .5 mile unlined open ditch drain, and .6 mile unlined wasteway for D77-78B, -78DD, -78P1, -114-2 and -30 drain systems, and W44A3 wasteway, Block 77.	M & J, Inc., Moses Lake, Wash.	413,628
100C-1071	Columbia Basin, Wash.	Aug. 21	Supplemental concrete lining of 4 miles of W61 lateral and modification of structures, Block 80.	Equipco Contractors, Inc., Ephrata, Wash.	109,371
200C-776	Central Valley, Calif.	Sept. 26	Rehabilitation of four timber bridges for Friant-Kern canal between Miles 24.80 and 30.46.	Thomas Construction Co., Fresno, Calif.	111,296
400C-420	Colorado River Storage, Colo.	Aug. 11	Construction of 12 miles and rehabilitation of 28 miles of access roads for Rifle-Hayden transmission line.	Nick H. Gray, Montrose, Colo.	121,762

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS
RETURN AFTER 5 DAYS

POSTAGE AND FEES
U.S. GOVERNMENT PRIN

Name

Street address

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

Enclosed find $............... (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

...... MINNESOTA. I 1.91:M 66	60¢	...... MARYLAND. I 1.91:M 36	
...... ALASKA. I 1.91:Al 15	65¢	...... WEST VIRGINIA. I 1.91:W 52	V
...... TEXAS. I 1.91:T 31	45¢	...... OHIO. I 1.91:Oh 3	
...... ARIZONA. I 1.91:Ar 41	45¢	...... WASHINGTON. I 1.91:W 27	
...... MASSACHUSETTS. I 1.91:M 38	45¢	...... NEW MEXICO. I 1.91:N 42	M
...... COLORADO. I 1.91:C 71	50¢	...... IDAHO. I 1.91:Id 1	
...... OREGON. I 1.91:Or 3	50¢	...... UTAH. I 1.91:Ut 1	
...... NEVADA. I 1.91:N 41	45¢	...... WYOMING. I 1.91:W 99	
...... CALIFORNIA. I 1.91:C 12	60¢	...... SOUTH DAKOTA. I 1.91:So 8	D
...... MONTANA. I 1.91:M 76	50¢	...... INDIANA. I 1.91:In 2	
...... PENNSYLVANIA. I 1.91:P 38	65¢	...... NORTH DAKOTA. I 1.91:N 81	D

Name ....

Street address ....

FOR USE OF SUPT. DOCS

MARYLAND

February 1970

RECLAMATION era

A WATER REVIEW QUARTERLY

February 1970 Vol. 56, No. 1

RECLAMATION
era

Gordon J. Forsyth, Editor

Contents

COVER PHOTO. Snow scene on Slide Mountain in the Sierras of Nev.-Calif.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Now For The 70's!

As one whose entire career has been either with the Bureau of Reclamation team or closely in touch with the agency's continuing achievements, I feel deeply honored to be appointed Commissioner by President Nixon.

The Bureau of Reclamation, in its 67 years of activity, has exerted a strong influence on settlement of the western half of America.

The Reclamation concept is one which truly "makes the desert blossom as the rose," but it also means new cities, new economic opportunities and an ever widening circle of wealth productivity which constantly contributes to the national well-being.

In contrast to successful water development in this country, I have seen tragic declines while serving as a consulting engineer overseas. One experience which always stands out in my memory was a confrontation by a group of tattered villagers forming a human chain-barrier in the path of a group of government officials and I who were inspecting a dry canal. At the bottom of the canal, looking up pitifully, were two listless youngsters about 8 years old with empty water buckets standing beside a hole scooped out of the bottom of the canal, in which was a little slimy water.

There clearly had been a lack of proper planning in letting the canal dry up. And the occasion vividly reaffirmed to me that hardship and chaos are too often reality for someone when we do not develop our resources wisely. Reclamation tradition and history have proven many times over that a civilization must be built on wise use of its resources of water, land and people. These resources are critically interrelated. They must be considered together and their total use planned in such a way as to enrich our civilization and to protect and enhance our environment.

The job Congress has given us to do is vital, and we are hopeful of a green light to expedite construction in needful areas as the budget crisis eases. We look forward with confidence to pushing for success of programs during the 70's which will benefit the people of America in this and future generations.

Ellis L. Armstrong

ELLIS L. ARMSTRONG
Commissioner of Reclamation

Commissioner Armstrong's Statement

The "Commissioner's Page" message, at left, to readers of *Reclamation Era* by Commissioner of Reclamation Ellis L. Armstrong presents some of the feelings this veteran engineer and administrator has about the organization he now heads.

The oath of office to Commissioner Armstrong was administered by Secretary of the Interior Walter J. Hickle last November 4, although his commission appointment by President Nixon was effective on November 1, succeeding Floyd E. Dominy, who retired October 31.

"NEW LOOK" PROJECT FOR LAS VEGAS

by ROBERT R. RISING and GAYLE A. ERICKSON
Reclamation's Office of Chief Engineer Denver, Colo.

SUNSHINE and desert plants dominate the scenery of southern Nevada. Near Hoover)am, one sees jagged mountains like saw teeth gainst the skyline.

Each year more and more people visit this fasinating region which also includes the famous ntertainment city of Las Vegas. It is a land of rare ontrasts from barren to oasis, and is one of the ıost popular vacation sites in the Nation. More ɔurists come than visit the Lincoln Memorial in Vashington, D.C., and the Statue of Liberty in Iew York combined.

At Hoover Dam, about 27 miles from Las Vegas, he registrants have been breaking visitor records or several years. The number doubled in just the ıst 3 years, and visits to the environs topped 4.7 ıillion in 1968.

People flock there because of the guided tours ıto inner workings of Hoover Dam and a number of other attractions: the scenery, fishing in the waters of Lake Mead behind the dam, and picnicking, hiking, and camping around the lake. This area was recently designated as the Lake Mead National Recreation Area.

The city of Las Vegas is a busy transportation stop for airlines, trains and highways; and is only six motoring-hours from the second largest city in the Nation, Los Angeles. Tour traffic from Las Vegas to Hoover Dam is heavy year around.

Las Vegas Boom

Las Vegas began rapid growth about 30 years ago, sustained by water that was easily available from underground supplies. However, as that city's population boom continued, demands arose for more water than was available in underground sources, and the focus was on nearby Lake Mead.

Gigantic Hoover Dam and many other multi-

purpose water projects on the Colorado River, and throughout the West, were built by the Bureau of Reclamation. Only recently this agency also was directed by Congress to construct, for the Colorado River Commission of Nevada, the water resources development called the Southern Nevada Water Project to serve the people there.

Also, nature has its own undisputed creations which are desirable at such recreation areas. For this reason the entire water transport project has been designed to a remarkable degree to be in harmony with the environment.

To ensure that scenic values would be preserved, Reclamation's architects and engineers worked closely with the Colorado River Commission of Nevada and the National Park Service throughout planning phases of the project.

Water Lifts

The project will convey water from Saddle Island near the shore of Lake Mead where pumping plant No. 1 will pump water into two systems. One system will lift the water 1,400 feet and transport it south to serve the Boulder City area. The other will lift the water 785 feet, cross the mountains to the west through the new River Mountains Tunnel, and then divide into two branches. One of these branches will serve the town of Henderson and other users to the southwest; the other branch will serve Whitney, Las Vegas, North Las Vegas, and Nellis Air Force Base to the northwest and north.

The fluctuating levels of Lake Mead require that withdrawals of project water be made from depths ranging to 179 feet.

When the system was in planning stages several years ago, there were three main alternatives for the principal pumping plant, No. 1, at Lake Mead:

1. Build the pumping plant on the east side of Saddle Island and pipe water across the island to the water treatment plant.

2. Locate the pump as noted above and convey the water by way of a tunnel through the island and a pipeline to the treatment plant.

3. Construct the pumping plant on the west side of the island. This would require a 13-foot diameter tunnel through the island to deliver water from Lake Mead to the pumps, then through a pipeline to the treatment plant.

Saddle Island is a true island only when the water surface in Lake Mead aproaches its maximum elevation. Because the water will frequently

Aerial photograph of Saddle Island at top, Hoover Dam at Bottor

This artist concept shows the appearance of the pump building and surge tank at Pumping Plant No. 1 on Saddle Island.

e low, it is necessary to tap the water on its deeper ast side. Deep water for the tunnel is an essential art of the third alternative.

dvantages of Third

The third alternative would cause fewer land cars above water level and be the least costly to onstruct.

To build the plant on the east side of Saddle sland would have required a different kind of ump and meant that an access road be cut along ne island's steep slopes in order to carry out contruction, operation and maintenance operations.

The island road excavations would have created ndelible scars visible for several miles up and own the lake. A similar sight would have been reated by a pipeline over the island.

It must be acknowledged, that if rock excavation techniques had not reached their present advancement, the first two alternatives would have been economically favorable.

Had there been less emphasis on planning to suit the environment, the conservative nature of the first two engineering designs might have influenced eliminating the third alternative.

Although some rock excavation has been necessary in the work on the third alternative, the visible excavation area is small.

Because the two structures at pumping plants Nos. 1 and 1A on Saddle Island will be in the same general locality and readily accessible to visitors, they both will have attractive and compatible architecture.

The form of surge tank was created to com-

plement the shape of the building walls and to be consonant with the flare of the fascia.

Pumping plant No. 2A is secluded in a relatively remote canyon. But because of the mobility of present-day exploring visitors, the same high quality architecture was used for it.

Kept Potable

All water pumped from Lake Mead by Pumping plant No. 1 will be processed by the treatment plant and will be maintained in a potable condition throughout the system. This plant was designed by Bechtel Corp. for the Colorado River Commission of Nevada, and the contract for its construction was awarded to Fred Early, Jr., Company, Inc.

Pumping plants Nos. 4, 5, and 7 are of the same style as the other plants in the system, but they are smaller. No. 4 on the Boulder City lateral is on the east slope of the mountains 500 feet above Lake Mead. Because of its location, it is expected that relatively few visitors will explore this plant, even though it may be viewed for some distance.

Pumping plant No. 5, similarly situated in relation to the mountain slope is within the city limits of Boulder City in an area of relatively low population density, but with good prospects for further city development in the near future. Plant No. 7 also is in urbanized Boulder City.

Pumping Plant No. 4 is 500 feet above dam on Boulder City lateral.

Pumping plant No. 3 is located in the heart of a residential section of Henderson, and No. 6 is in a potentially urban area east of Las Vegas.

Safety precautions have been included at facilities throughout the project. Electrical switchyards and equipment will be fenced or enclosed in accordance with best safety practices. Dangerous slopes also will be fenced, and ladders which could be hazardous to visitors have been eliminated wherever possible.

The only building which will be regularly attended is the water treatment plant. Visitor facilities will be provided there and, to a limited degree, in pumping plant No. 1A.

Also designed with aesthetics in mind are the 7 power switchyards located at each of the pumping plants except one. The switchyards are of the low-profile type and are positioned to not be skyline features.

Landscaping

Landscaping around all structures is to include trees and shrubs which thrive in the Southwest desert. As is a common practice in this region, rock mulch and native vegetation will be used in lieu of grass as ground cover to blend with the natural surroundings and avoid excessive watering care.

Water will be supplied to the landscaping trees and other plantings however, either by sprinklers with automatic timing controls, or by "dribbler" systems. Dribbler systems apply water at each tree and plant in carefully regulated amounts, a drop at a time, continuously.

Recreation considerations have been taken into account for the area of the subsurface tunnel at Saddle Island. The intake of this 13-foot tunnel will be screened to prevent scuba divers from entering the danger area and to protect the system from trash in the water.

Nevada fish specialists do not believe significant numbers of game fish will be drawn into the pumps, because none but mature fish will swim as deep as the intake during normal reservoir conditions. Mature fish will be strong enough to swim against the relatively slow velocity—less than 5 feet per second, maximum—of the water intake. And if the need becomes apparent, special fish screens can be installed in the access shaft.

This project is reassuring to the future municipal and industrial water needs of southern Nevada and it is a "new look" example for the development of other projects to come.

# # #

Renowned artists enthusiastic on visits to scenic projects

Reclamation Launches Art Program

by JOHN DeWITT
Washington, D.C.

RECLAMATION projects as seen through the eyes of a number of the Nation's leading rtists, are being depicted in paint for ultimate lisplay in project visitor centers and elsewhere. 'irst however, the paintings will be shown in a raveling art exhibition which is now being booked n major galleries throughout the United States.

The new venture began early in the summer of 969 with the commissioning of a number of seected artists to visit its water resource developnent sites throughout the Western United States nd record their impressions in paint.

The artists are given a free hand in their work—hey can depict a dam, a reservoir, an irrigated ield, a transmission tower, a turbine, a water skier, almon climbing a fish ladder, waterfowl on a refige—anything that happens to engage their fanies, as long as the subject matter pertains in one vay or another to the Reclamation program.

The artists are welcome to depict the Reclamaion program in whatever style or medium they hoose. An abstraction is fully as acceptable as an ntirely representational canvas. The artists are sked only to paint their individual reactions to vhat they see, in whatever style and medium they hoose.

Goodrich of Whitney Museum

The artists who are invited to participate in the Reclamation art program are selected by Dr. Lloyd Goodrich, advisory director of the Whitney Museum of American Art in New York City. The vriter of this article serves as art program co-

Famous Norman Rockwell, marvelling at scenery, said, "perhaps I could work some people into it"—painting of Glen Canyon Dam.

ordinator in the Commisioner's offices and accompanies the artists on their sketching trips to project areas. Each artist is reimbursed for his travel and daily expenses while in the West. The artists complete their paintings in their own studios and each receives a modest honorarium on submission of his completed work.

Rockwell At Glen Canyon

Perhaps the best known of the artists who have participated in the art program as of this writing is Norman Rockwell, whose name is known literally all over the world for his penetrating illustrations of the American scene on the covers of the *Saturday Evening Post.* Rockwell was invited to visit Glen Canyon Dam and Lake Powell and contribute his reactions to the area in paint.

Mr. Rockwell was delighted to participate and marvelled at the magnificence of the scenery that unfolded before his eyes. But, at first, he was modestly dubious of his ability to contribute anything of value to the art program.

"I am a people painter," Rockwell said, "not a landscape artist. You would like a painting of Glen Canyon Dam, I suppose. But if I do it, I'm afraid it might look like a mechanical drawing—lifeless . . . unless, perhaps, I could work some people into it?"

He was assured that he could. Rockwell then looked out at the streets of Page, Ariz., from our restaurant booth, searching for an idea that wasn't long in coming. The idea took the form of a passing Navajo Indian, one of the traditional "longhairs," his tightly bound pigtail down the back of his colorful, if quite seedy, costume.

Soon Rockwell had conceived the notion of using a trio of Navajos, the woman on a horse, the man standing, holding the hand of a small child on his right, his left hand holding the horse's bridle. The group would be perched near the canyon rim, looking upstream at Glen Canyon Dam. The trio and the horse would be in shadow, Rockwell went on, doing a rapid sketch on a napkin as he talked, and the dam would be in bright sunlight with Lake Powell in the background stretching up into the Utah canyonlands. Rockwell continued sketching away. "You don't mind if I put that butte in the background, do you? . . . what's it called? . . . I need it to balance the canvas."

Rockwell was granted artistic license to move Tower Butte, a dominating landmark some 15 miles away, and place it wherever he wanted to.

Despite his napkin-sketching, Rockwell relies mainly on photography for guidance in his work, with Mrs. Rockwell serving as his official photographer. The Indian group and the horse were posed and photographed on the shady side of a barn, while countless photos of the dam and Lake Powell were taken from the canyon rim, from an airplane, and from a boat.

When last heard from, Norman Rockwell was back at his studio in Stockbridge, Mass., putting it all together on a canvas six feet long by four feet high.

Fausett Brothers

Artist Dean Fausett, who also participated in the Glen Canyon trip, works in quite a different fashion. While he takes some photographs too, Fausett sets up a complete outdoor studio when on location, rises with the sun, and has an oil painting half finished by breakfast time. While traveling from one location to another, this prolific artist keeps a sketch pad on his knee, and often produces as many as a dozen sketches in the course of an hour. Lynn Fausett, older brother of Dean, works in a similar fashion, though more deliberately. The elder Fausett is now at work on a painting of Flaming Gorge Dam in his Salt Lake City studio.

McCoy and Hurd

From experience gleaned on swings through the West with the 10 artists so far commissioned for the Reclamation art program, it might be noted

John McCoy sits to get low-angle view for a sketch at Shasta Dam.

at family members tend to adopt similar meth-
ls in approaching their work, though their final
roducts may be and usually are—quite
ssimilar.

John McCoy and Peter Hurd, for example,
e both brothers-in-law of famed artist
ndrew Wyeth in addition to being fine painters
their own right. Both execute quite careful
ater colors of their chosen scenes, sometimes tak-
g 3 or 4 hours in the process. While at work,
urd welcomes rubberneckers and conversation;
hile McCoy prefers to concentrate in silence.
urd did his work for the art program at Ele-
iant Butte Reservoir in New Mexico, while Mc-
oy selected the Shasta-Trinity-Whiskeytown
ea in California.

amieson

Mitchell Jamieson, on the Fryingpan-Arkansas
roject in Colorado, used the pen-and-ink technique in his field work. Jamieson's favored location was Ruedi Reservoir. On a fold-out drawing pad, Jamieson made a drawing of the Ruedi shoreline which fanned out, Japanese-style, into a three-foot long panorama, which could stand on its own merits without further embellishment.

dely celebrated artist Peter Hurd may do both oil painting and
ter colors at Elephant Butte Dam and Reservoir, N. Mex.

Goff

Lloyd Goff, on the Curecanti Unit, relied on splapdash sketches taking no more than 30 seconds each. They meant little or nothing to an observer, but apparently told artist Goff all he needed to know about the scenes he planned to paint in his studio.

Laning

Edward Laning took a diametrically opposite approach, spending 2 days on a painting at Jackson Lake, a day at Buffalo Bill Dam, and two more days at Yellowtail Dam, producing finished watercolors at each location. Laning is now at work translating his watercolors into oils.

Maril

Herman Maril took yet another approach to his work on the San Juan-Chama Project. Maril made occasional sketches with a heavy felt pen of his own design, but in the main was content to merely look and ask questions. Maril said he liked to store his impressions up in his mind and needed no photographs and very few sketches.

Crawford

The method employed by Ralston Crawford at the Grand Coulee Third Powerplant came as another surprise. Crawford, who perhaps paints least what the camera sees, of the artists of the group, took the most photographs, relying mainly on his two motion picture cameras. Alone among the group, Crawford never drew a line while in the field. He will run his movie sequences off at home in his studio, he said, and from those will come his ideas for paintings.

(Continued on next page)

(Continued from preceding page: "Reclamation Launches Art Program")

Artist Crawford starts his work with movies at Grand Coulee Dam.

Obviously, each artist makes up his own rules of the game—and if he didn't, he wouldn't be an artist. There is little doubt but that the artists' versions of the Reclamation program, when gathered together and exhibited, will reveal an entirely unique montage of the Bureau's work and accomplishments.

Insight to Reclamation Benefits

The exhibition will open in Washington, D.C., sometime during the winter of 1970–71 and will then be sent on tour of major art museums in all sections of the United States. In addition to their inherent value as works of art, the paintings in the show will provide valuable insight to a great many Americans who are as yet largely unaware of the productive results of Reclamation's water development projects.

The artists are being asked to submit their preliminary sketches, drawings, and watercolors along with their finished paintings, even though these "notes to themselves" will not appear in the exhibition. Reason for this request is that these on-the-spot efforts often have an impact and immediacy which finished works of art lack. They may easily reveal to future generations impressions of the West in our time that would otherwise be lost.

Sketches Also For Exhibit

Later, when the finished works are displayed in Reclamation's visitor centers, the preliminary sketches, drawings, and watercolors will be mounted and hung along the tour route corridors through the dams and powerplants. The blank tile walls that now separate points of interest along the tour routes will then become lively points of interest in themselves.

Why does the Bureau of Reclamation feel the need to engage artists to depict its projects when the photographic record of its installations is so complete?

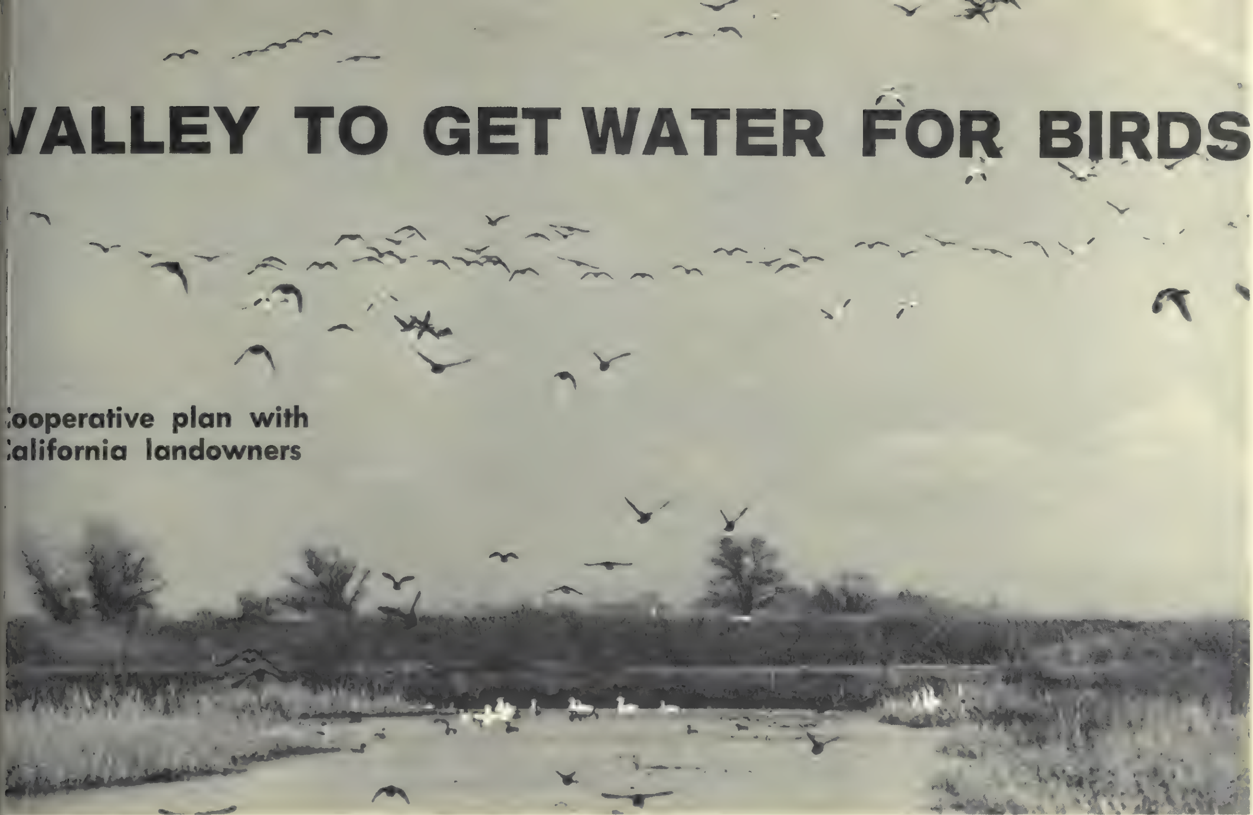
The answer was perhaps best expressed by the French artist Honore Daumier over a century ago when he said "the camera sees everything and understands nothing." The camera is unable to feel, to select, to discard, or to think, Daumier felt.

Only an artist, viewing a scene through his own eyes, and capable of synthesizing his intellectual response and his imagination on paper or canvas, can provide the intrinsic graphic statement.

# # #

VALLEY TO GET WATER FOR BIRDS

Cooperative plan with California landowners



A 46,000-acre waterfowl habitat in San Joaquin Valley, Calif., which requires flooding twice a year, will get its water supply from the Bureau of Reclamation's Central Valley Project.

Reclamation and the Bureau of Sport Fisheries and Wildlife, both Interior agencies, are working with private landowners to preserve the important habitat at about one-tenth of what it would cost the Federal Government to do the same job alone.

Involved is part of the flat grassy terrain floor in the Grasslands Water District of Merced County.

The District has agreed to flood the area in the spring with water supplied by the Bureau of Reclamation to assist waterfowl production, and again early in the fall as an aid to early winged migrants in the Pacific Flyway. It also will release water for the nearby 5,900-acre Kesterson waterfowl management area operated by the Bureau of Sport Fisheries.

Bird specialists in the SFW agency conducted studies which showed that $575,000 per year would be required to operate a publicly owned management area to compensate for the loss of the privately owned habitat, if it were not available.

The birds shown above are in a much-used refuge many miles north of the proposed refuge noted in this article, and both areas have the water service of Reclamation's huge CVP in California.

Reclamation's Central Valley water project includes systems of dams, canals, reservoirs, water tunnels, power and pumping plants which have been providing solutions to a number of problems of residents of the rapidly growing California for more than the last 20 years. Parts of the project are still under construction.

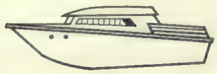
Marshlands Needed

"The steady and unrelenting reduction of marshlands in the San Joaquin Valley," states an SFW report, "has resulted in the crowding of wintering waterfowl areas of limited size. Consequently, the remaining habitat base, the Grasslands, is vital to the maintenance of waterfowl resources of the Pacific Flyway."

It is believed that spring flooding of the 46,000-acre habitat will produce about 8,000 ducks. The valley is a favorite wintering ground for waterfowl—mallards, pintails, green-winged and cinnamon teal. Widgeon and shovelers are common and several species of geese also winter in the area.

The agreement planned assures that nearly one-half of the remaining waterfowl habitat in the valley will be maintained and improved for these birds. # # #

Unlikely place for launchings



BOATING on Backbone of the Rockies

by NELLO CASSAI, Information Officer, Regional Office, Denver, Colo.

BECAUSE it is an inland and mountainous state, Colorado would seem to be an unlikely place to launch a boat.

Yet, during the warm time of year, boats are on the move by the hundreds. Few people even take a second look at boats being towed on lofty highway passes crossing the Continental Divide, which once defied those stout souls who searched in vain for a feasible transcontinental railroad route through the Nation's highest state. Its average altitude is 6,800 feet.

Almost 25,000 boats were licensed last year in Colorado, which also honors boat licenses of visitors who flock here in summer to escape the heat and perhaps catch a few trout.

Licensed craft range from small motorboats to ponderous motor cruisers. No licenses are required for hand-propelled vessels such as rafts, kayaks, or canoes.

The increasing popularity of boating in Colorado and Wyoming—its mountain neighbor to the north—is due largely to the pleasure, sport, and accessibility afforded by the chain of high altitude manmade lakes created by the Bureau of Reclamation on its multipurpose projects.

Twenty-four of these impoundments wholly in Colorado provide a total water surface area of almost 35,000 acres and 300 miles of shorelines. Navajo Reservoir, on the Colorado-New Mexico line, provides another 150 miles of shoreline.

Biggest Reservoirs

Only 10 percent of Colorado's population of about 2 million lives west of the Divide—but that's where most of the water and big Bureau reservoirs are.

Highways spanning the Rockies thus serve as inland passages between the Atlantic and Pacific watersheds for the mountain mariners.

Highest of the Bureau impoundments in Colorado is beautiful Turquoise Lake, west of Leadville, at an elevation of 9,850 feet above sea level. Longjohn underwear temperatures prevail there at night but swimmers may be seen on warm days, along with bank fishermen, boaters, water skiers, campers, and picnickers.

These and other activities are permitted at most of the Bureau reservoirs.

Tunnel From Turquoise

Turquoise, which at capacity will cover 1,800 surface-acres, is a feature of the Fryingpan-Arkansas Project being constructed by the Bureau to divert water from the Fryingpan River on the western slope to the Arkansas River on the eastern slope via a 5.4-mile tunnel piercing the spine of the Rockies.

Lake Granby and Shadow Mountain Lake, near the western entrance of Rocky Mountain National Park, and about a 3-hour drive from Denver, are the top water attractions in Colorado, drawing well over 1 million visitors a year.

Lake Granby, with a 40-mile shoreline, is preferred by the speedboat-ski set, but trollers and bank fishermen also swarm to both lakes in pursuit of brown and rainbow trout and kokanee salmon. Administered and developed for recreation by the National Park Service, these two reservoirs are vital links in a farflung water network known as the Colorado-Big Thompson Project.

Farther from Denver (a 5–6 hour drive) is a newer and bigger Reclamation impoundment, Blue

Boats being towed over the Continental Divide in Colorado is a common sight with the increase in recreation at reservoirs.

Iesa Reservoir, with a 70-mile shoreline. It is on ie Gunnison River just downstream from the own of Gunnison, long a favorite summer gathering place of Texans and Oklahomans.

Trophy-sized rainbows and browns are taken rom Blue Mesa, as well as from the river.

Because of its distance from large population enters, and not being fully developed for recreaonal use, Blue Mesa doesn't yet attract as many isitors (370,000 last year) as have other large ureau reservoirs. Still, it has generated brisk trafc on summer weekends and those who don't own ampers or trailers are advised to make lodging eservations well in advance unless they want to ough it.

Visitors to all Bureau reservoirs in Colorado otal almost 3 million annually.

Vyoming Waters

Accessible to Wyoming sportsmen are waters f 24 Bureau reservoirs having a combined normal ater surface area totaling 198,000 acres and proiding 1,300 miles of shoreline.

Visits to these impoundments in Wyoming last ear totaled more than 6.3 million. This includes ureau waters shared by Wyoming and adjoinng States, such as Flaming Gorge on the Green iver, Utah, and Yellowtail on the Big Horn iver, Mont.

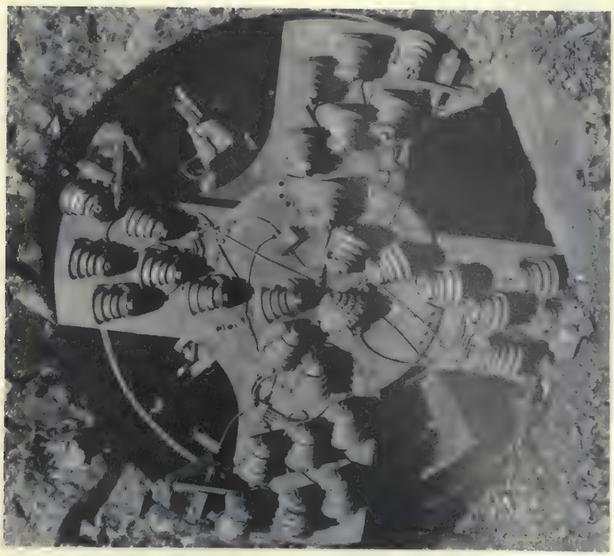
Boats licensed in Wyoming last year totaled ,880—in a State having a population of only bout 320,000.

Thus in Wyoming there is one boat registration per 47 residents, while Colorado has one boat registration per 80 residents.

Reclamation projects throughout the West provide 232 public recreation areas on 3.8 million acres of land, 11,400 miles of shoreline and 1.7 million acres of water surface developed for recreational use. # # #

There definitely is boating and may still be water's edge camping at beautiful Shadow Mountain Lake, Colo., as in this 1961 photo.

WATER Quiz



1. The population within 40 miles of the reservoir called Lake of the Arbuckles in ← Oklahoma, shown here, is about 182,000 people. Would you guess that 200,000 visitor-days spent at the lake is setting the count too high for fishermen and other recreationists for 1968?

2. Fishing is second only to sight-seeing in recreational activity at most of Reclamation's 232 public recreation areas. Try choosing the correct 1968 total in sportfish caught in all the areas.
   a. 50 million
   b. 5 million
   c. 20 million

3. Which U.S. President signed the Federal law in 1902 creating the Bureau of Reclamation, and is the one for whom a dam in Arizona is named?

4. The States with the most irrigated land in this country, listed alphabetically, are California, Idaho, and Texas. Which are 1, 2, and 3 by amount of land irrigated?

5. This rock-chewing machine is emerging from ← boring a new water tunnel 12 feet in diameter through a Nevada mountain last June. What is the 4-letter nickname for the machine?

ANSWERS:

(1.—Too low; visitor-days were 339,000. 2.—c. 20 million. 3.—President Theodore Roosevelt. 4.—California, Texas, Idaho. 5.—Mole.)

Extends boating season

House Cleaning at Lahontan

by JOYCE HOFF, Bureau of Reclamation, Sacramento, Calif.

THOUSANDS of trees have been rammed, sawed, and dynamited out of the Bureau of Reclamation's Lahontan Reservoir in Nevada.

The removal—mostly of cottonwoods—has made it much safer to boat and water ski when the lake level is low, thus extending the boating season by 4 to 6 weeks.

There was little or no potential for boating or water skiing at Lahontan Lake when Reclamation built the dam and reservoir 54 years ago. A tree clearing expense would have been extra. But with the recent increase in recreation, the tree clearing became important to do, and was accomplished last year by the Churchill and Lyon Counties Bi-County Parks and Recreation Commission.

It was necessary that the clearing take place after much of the water from the lake had been released for summer water and power needs on Reclamation's Newlands Project. Capacity of the lake is 273,600 acre-feet, and the releases had reduced below half, the amount exposing sufficient parts of the trees and stumps above the surface to allow removal of adequate lengths.

It is apparent that if the dead tress in a reservoir are short and covered by high water most of the year, as was the case at Lahontan, they could not be useful for bird nesting. Wildlife experts confirm however, that nesting of rare ospreys has proven succesful in the tops of much taller pine trees in Crane Prairie Reservoir, Oreg., noted in the November 1969 issue of *Reclamation Era*.

Will Aid Fish

Meantime, the abundant fish population at Lahontan will continue to find habitat benefits from the underwater tree remnants.

The clearing took place in the Virginia Beach area. The trees ranged in thickness from 3 inches to 4 feet.

Smaller trees were rammed and snapped off by a raft built by Recreation Commission members from a dock floated on styrofoam which had been used as packing material by a nearby Naval Air Station. The raft was 12 feet long and 8 feet wide, weighed about 700 pounds and was powered by two 10-horsepower motors.

Most of the larger trees—those that weren't petrified—were cut down with power saws. Planks were extended from the raft to form a "V" from which men could work simultaneously on two sides of a tree.

The petrified trees posed a special problem; it took 2 days just to get rid of eight or nine of them.

Working from a 16-foot outboard motor boat, the Commission members and a mining engineer, who was experienced in dynamite work, drilled six or seven holes about halfway through the trees and then stuffed the holes with dynamite.

Blasted Holes

Even with the charges going off simultaneously, some of the trees had to be dynamited several times—one as many as five times. Sometimes all

Working from edge of raft, a power saw fells this dead tree as a first step to clearing boating area at Lahontan Reservoir, Nev.

the dynamite did was blast bigger holes in the trees, and new ones had to be drilled for another shot.

Complicating matters even more, some of the trees were hard on the outside and spongy inside, others were hard on the inside and spongy outside, still others were hard both inside and outside.

In order to prevent harming the fish in the lake, the dynamite was used just above the water surface.

It took about 6 weeks to complete the job. Then came the problem of removing the felled trees from the reservoir—another slow process.

After several attempts, the Commission decided that the best way to get the trees out would be to corral them by cable into a bay at high water level. They would be high and dry when the water level receded further, and could be bulldozed out and used by campers for firewood.

Funds for removing the trees from this area by the Carson River were provided by the State Motor Boat Fuel Tax fund.

Booster Morgan

Freeman Morgan, chairman of the Recreation Commission, is one the lake's greatest boosters. He talks eloquently of the excellent fishing in the lake; the many campsites with ample shade from scattered groves of cottonwood trees around its 69-mile shoreline; relatively warm water for swimming; areas accessible only by boat for those who like remote, private areas; good hunting in the late fall for ducks and geese; 300 sunny days a year. Even when the lake is frozen over and there are patches of snow on the white sand you can walk along the shore without a coat or sweater and still be comfortable.

Lahontan will become even more attractive to recreationists now that an agreement has been signed by the Bureau and the Recreation Commission and the Truckee-Carson Irrigation District (the District operates the dam and reservoir).

Match Recreation Funds

This recreation agreement provides that the Bureau will match funds with the Commission up to $100,000 for recreation facilities—boat ramps, campgrounds, sanitary facilities, picnic grounds,

Clearing will remove all trace of these trees from this Virginia Beach area, popular for boating during warm high water season.

fishing, and swimming areas. A plan for the development has been prepared in cooperation with the National Park Service.

Lahontan Reservoir, as part of the Newlands Project, is one of the first Reclamation projects, dating back to 1903. Work on the dam began in 1911 and the finishing touches were put on it in 1915.

The dam is on the Carson River but also stores water from the Truckee River about 18 miles away; Truckee River water is transported to the reservoir via canal. Water from the project is used to operate the Lahontan Powerplant and it irrigates lower Carson Valley areas near Fallon.

Removal of the hazardous trees from the key boating area results in a pleasurable plus for persons enjoying the multiple purposes of Lahontan Lake. # # #

Landmark effort in irrigation industry

Bold New Development for Irrigation

MORE than 7,000 years ago, primitive man first applied water to his croplands and began the science of irrigated agriculture.

Today an estimated 385 million acres of the earth's surface—an area equivalent to that of France, Spain, and Western Germany combined—are under irrigation, and the total is growing annually.

But as vital its contributions to the world's marketplaces, as sophisticated the tools and machinery of irrigation, there remains a dilemma for man in the irrigation field throughout each growing season.

Precisely when and in what amounts should he apply water to a crop for peak efficiency?

Irrigation scientists generally agree in existence of the paradox that: Irrigators are perennially concerned with too-short supplies of water yet too much water is applied to the fields under current watering practices.

The result is a complex melange of wasted water, increased costs, reduced production, and lower farm efficiency.

Strikes Contradiction

To strike at this contradiction, the Bureau of Reclamation has brought a wide range of scientific talents to bear on the issue, and has started a pilot program of scheduling irrigation water deliveries. With it, Reclamation spokesmen say, they intend to demonstrate dramatically that irrigators can:

1. Achieve higher crop yields with less water.
2. Reduce their investment in time and labor.
3. Use less fertilizer.
4. More easily maintain the fertility of their croplands and the quality of runoff water.

In a scientific soil-moisture test, core samples are drawn from ground with an auger and placed in cans—Seedskadee Proj., Wyo.

At the heart of this bold claim is a Bureau of Reclamation study that began 5 years ago. The study involved a water budget analysis for each of some 300 farm fields at strategic locations throughout the Western United States.

Included were detailed measurements of water delivery to the farm, farm ditch losses, water delivered to the individual fields, and surface runoff. Precipitation and temperatures also were recorded, as well as solar radiation.

The study areas are located in each of the Bureau's seven regional areas, and represent a wide range of climatic conditions, soil types, varying slopes, irrigators techniques and other conditions under which irrigation is practiced.

From this study, scientists made conclusions which reflect the scope and depth of the contradiction in irrigated agriculture.

First, scientific measurements are not available and as a result many irrigators are applying two and three times more water than is required for given crops. Even on individual fields, there is a very erratic pattern both for times and amounts of water applied.

Next, it is apparent that irrigation water usage is geared to seasonal water allotment, and it is the allotment which determines in large part the seasonal irrigation efficiencies.

Over-Irrigation

Finally, almost universally, over-irrigation occurs during the early and late portions of the season, and often under-irrigation during the peak growing period.

The study clearly shows that irrigators today generally do not know the moisture-holding capacity of their soils, and neither do they know the soil moisture depletion in the effective rooting zone of the crop—perhaps the two most critical factors in determining when to irrigate.

For this reason, the irrigator generally schedules his irrigation by the calendar. Also he is inclined to allow the water to run on a field for a certain number of hours that fit into his schedule of other work, rather than to compute the irrigation time needed on the basis of depleted soil moisture.

To provide the data scientists have come to recognize as critical for efficient irrigation, the Bureau of Reclamation is proposing this program of management.

It involves the scheduling of irrigation water deliveries using direct, scientific means.

The concept is not new. Professional irrigation management programs have been available for more than 20 years in the southern San Joaquin Valley of California. There, a number of commercial operators using tensiometers to measure soil moisture are providing service to orchard owners.

Washington State Univ. Effort

Washington State University has introduced irrigation scheduling on the Bureau's Columbia Basin Project. Dr. Marvin Jensen of Agriculture Research Service has developed a water budget approach using his consumptive use procedure to predict soil moisture depletion.

Dr. Jensen is presently scheduling irrigation for more than a score of farmers in southern Idaho using solar radiation, air temperature, rainfall, and time of irrigation application as his input items. In 1965, the Salt River Project Water Users' Association began soil moisture service to irrigators in the Phoenix, Ariz. area.

In the latter activity, specialists visit water users and assess with them the soil water content of a particular field based on physical soil moisture sampling. From the initial service provided by two technicians to some 14 farms totaling 12,000 acres, it has climbed to include 6 technicians, 2 laboratory

men, and one engineer serving about 140 farms and 80,000 acres.

What have the results been?

Cotton yields have been increased by one-quarter to one-half bale per acre, or as much as 20 percent. Irrigation applications have been reduced by 20 to 30 percent. Annual costs of about $1 per acre have provided benefits on the order of $35 per acre.

The economic benefits take on even more significance when considering the reductions in seasonal water use. These reductions can obviously make possible the delivery of water to increased acreage. Some authorities contend that water savings could be sufficient to ease or even erase the water shortages now occurring in many irrigated areas.

The key to the success of scheduling programs, as many see it, is physical as well as technological. They place technicians in the field, in direct and continuing contact with the irrigator.

Left. In this well-refill test in North Dakota, the specialist at left pumps all water from the shallow well, the white float will be dropped into the cavity by the man at center, and time of refill will be recorded on the plotting stand at right.

Below. This irrigator near Rupert, Idaho, gets water to a radish seed crop the conventional way. Plans are underway for water deliveries in this area to be made with scientific accuracy by computer.

Rely on Calendar

Various tools and methods to aid irrigators have been developed in the past, but too often their use is a matter of the irrigator's own initiative. Just as often the farmer is inclined to rely on past ex-

370-425 O—70——3

perience, the calendar, or the general appearance of his crop to schedule his irrigation.

In most successful irrigation scheduling programs, it is apparent that the personal contact of the technician is the most important element for success.

In preparing to pass results along to the irrigator, the technician uses familiar tools. He can use a probe to obtain soil samples from the crop rooting zone with a minimum of time and effort. Another basic but time-consuming method of determining soil moisture levels is the gravimetric procedure, where soil samples are taken in the field, weighed, and dried in an oven.

More recently, a neutron soil moisture meter has been developed to measure soil moisture without removing a soil sample. And finally, there are a number of special instruments which are commercially available for measuring soil moisture tension.

Reclamation authorities envision the use of these tools and methods in whatever combinations are required to best serve local needs.

Computers Proposed

Central computers already have been proposed and put in use for some advanced irrigation scheduling programs, computing irrigation times and amounts from input data that includes solar radiation, air temperature, rainfall, and time of the last irrigation application.

In its proposed scheduling program, the Bureau plans to absorb the cost of developing and perfecting the program for project areas. Once it becomes operational, the cost would shift to the irrigators or to their organizations.

The Bureau's initial function would be to determine personnel and equipment requirements, provide training for all technicians, establish procedures, and to provide full supervision during the first season of operation.

Participation by the irrigation districts and their members would be entirely voluntary.

One Man for 20 Farms

Commissioner of Reclamation Ellis L. Armstrong says preliminary studies indicate a single specialist, equipped with the necessary tools and laboratory support, would be competent to provide irrigation scheduling service to 20 farms on a once-a-week basis.

Already, Commissioner Armstrong said the Bureau has been approached by several organized irrigation districts, seeking implementation of such a program.

Budget considerations will play a major role in determining how rapidly the Bureau can put the program in practice. But plans are in progress now to establish an operational program on the A and B Irrigation District of the Northside Pumping Division, Minidoka Project, near Rupert, Idaho.

Additional programs will be started as availability of funds and manpower permit.

"The conclusion is inescapable," says a Bureau of Reclamation report on the 5-year study and the proposal. "Without the availability of an irrigation management service, the farmer will not achieve the higher levels of water use efficiency and yields he is capable of.

"And without such a service, the Bureau of Reclamation could not realistically design projects on the basis of the higher efficiencies which can be achieved. We have the responsibility, but more important the opportunity, to perform a real service." # # #

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

Saves water, cuts dollars for RWCD

Concrete Work Pays Off

by **ERNEST DOUGLAS, Editor**
Arizona Farmer-Ranchman

WHEN the landowners of the Roosevelt Water Conservation District (RWCD) received their tax bills last September, they should have been pleased to find that their annual district assessment had been reduced from $7 to $5 per acre. Their total saving, on 37,000 acres, will be $74,000.

The RWCD was able to receive this advantage because 6,000 acre-feet less water was needed to put the same amount of water to use on the farms. In other words the same job is being done with 6% less water.

District operating costs have been cut in other ways, too. It used to have a general labor crew of six men and a foreman, and a weeding crew of three. Now there is just one crew, three men, presently engaged in weed control.

And that control will soon be saving the farmers thousands of dollars a year in fighting weeds on their own property.

How does all this come about? Well, the RWCD—located 25 miles east of Phoenix—is within a year of completing a rehabilitation program financed with a $4.8 million loan from the Bureau of Reclamation. It is repayable in 50 yearly installments after completion. The first installment, $70,000 will be due in 1972.

And the water users, in this fiscal year, will enjoy a savings $4,000 greater than that, besides other blessings.

They pay for their system's operation in two ways. First, there is the per-acre assessment, collected through the regular Maricopa County machinery. On top of that they pay $8.50 for each acre-foot they use.

In photo above, the canal was transformed by men and machines.

Power and Other Costs

The actual cost of producing water, according to Supt. Virgil McClanahan and his calculator, is $9.37 a foot. It's the assessment that keeps the books in balance.

Since there is clearly a water saving of 6%, the directors decided that $5 an acre would be enough for the current year.

This saving is effected because the entire lateral system, 115.5 miles, is now concreted or underground. One is now a conduit for a mile and a half

of its length; the other laterals are open ditches, lined by the Fullerform slip-form method.

This has cost just about $3 million. The first contract was for 41 miles, let in the fall of 1966 to the Hunter Contracting Co. of Gilbert. The others have gone to the Fullerform Co. of Phoenix, whose president is Bud Fuller, inventor of a fast and economical method of lining that has saved irrigators countless millions.

Fuller finished his last lateral contract on June 30, 1969. While this was in progress he was relining three miles at the lower end of the main canal and lining 4.5 miles of the main canal's extension in the south end of the district which had never been concreted.

Just last month, Fuller won a $1,200,000 contract for lining 10.5 miles of main canal, and finishing the remaining 5 miles of the extension.

When the project was constructed, nearly 40 years ago, the canal was gunite-lined from end to end. Now that 10.5-mile stretch is in such bad condition that the lining has to be pulled out and replaced.

All Over in 1971

This job, to be finished in the winter of 1969–70, will leave 10 miles of canal in need of attention. It has been decided that repair will be sufficient. Bids on the final phase of the rehabilitation program will be called for about a year from now.

About $4.5 million of the loan that was granted under the Small Reclamation Projects Act will then have been expended on construction, and the remainder on engineering that was mainly done by W. S. Gookin & Associates. There may be a little left, McClanahan says, for work on the 53 wells that supply most of the district's water. But they are kept in good shape as part of the regular maintenance program and no major attention is necessary.

It may be hard for one who has never managed an irrigation system to understand why lateral concreting can save 6,000 acre-feet a year in a project that embraces only 38,000 acres, and that including 1,000 owned by the district itself. But listen to McClanahan, who is responsible for water deliveries for a number of years before he became superintendent.

Time Cut Two-Thirds

Take a head of 250 miner's inches, which must

Before recent construction, this weed-infested section of the main canal had an old cracked, and leaky concrete lining.

be conveyed from the canal to a farm three miles away. When the laterals were unlined ditches which quickly became choked with weeds unless cleaned regularly, it took three hours for the 250-inch head to travel 3 miles.

Now it takes 1 hour.

Formerly the zanjero had to open the turnout gate 3 hours before the farmer received any water. He closed the gate 3 hours before the farmer's water run was to end. Now 1 hour, either way, is sufficient.

And practically every lateral was scoured a few inches to a few feet deeper than its original bottom. That space had to be filled before the water could proceed on its way. When the turnout was closed, those long holes were left full of water to seep away or evaporate. Waste!

In transmission, therefore, is where most of the water saving comes about.

Laterals once had to be repaired and cleaned constantly. Old structures had to be mended. The battle with weeds along the laterals was endless. Tumbleweeds grew there, and horsenettle, and Johnson grass, not to mention a dozen annuals such as mustard. Many of their seeds got into the water, to flow on down to the farm fields and sprout.

"Every berm was a seed-production field for the farmers," McClanahan says.

The battle was carried on mainly with weed oil. In 1967–68 alone, that three-man crew sprayed 87,000 gallons of oil. The weeds were set back some, but no more.

low there's no trouble from gophers or water weeds, no seepage, nd much less evaporation since the water travels much faster.

The end of seepage has made those berms considerably less hospitable to weeds. Nevertheless, umbleweeds, horsenettle, and certain annuals get long well on rainfall, and Johnson manages to ive and ripen seeds.

witch to Chemicals

Last winter the decision was made to forget bout oil and swing to herbicides, eradicate those veeds and never let them come back. So the crew s now spraying Atrazine. It's not the entire nswer, McClanahan says. Johnson isn't much ffected by it, and horsenettle isn't affected by anyhing. But all the laterals will be given the Atraine treatment at least once, and maybe other hemicals will be tried. Retreatment will probably e necessary every 2 or 3 years.

Farm outlays for weed control should now be reluced sharply. There's even a possibility that the perators can get together on a community-wide rogram and reduce those outlays to insignificant roportions.

That, however, is in the future and somewhat ndefinite. Right now the farmers can look at their ax statements and know that there total costs have een chopped by $2 an acre. There are bound to e still more tangible and intangible gains before hey have to start paying back that $4.8 million oan. # # #

(*Permission for use of this article is from the uthor, Mr. Douglas. It first appeared in Arizona Farmer-Ranchman of Sept. 20, 1969.*)

NEWS BRIEFS

Double Reward

Reclamation foreign training program reaped a double reward last fall. Mrs. Ahmad volunteered her services at the Coulee General Hospital while her husband, Nafis Ahmad, a civil engineer from West Pakistan, was attending Grand Coulee Dam Third Powerplant on a training program.

Mrs. Ahmad has four sisters, all with advanced degrees in their chosen fields, one of whom is a medical doctor in Miami, Fla. Her gracious manner, winning smile and capability to serve and please endeared her to both hospital staff and patients.

On Navajo Water Project

In late 1969, three 17.5-foot in diameter siphons and two concrete-lined sections of the Main Canal were completed on the Navajo Indian Irrigation Project, N. Mex.

The siphons total length is approximately 11,700 feet, while the two concrete-lined stretches of canal have a combined length of 2.7 miles.

This concludes work on the $6,730,000 contract which was awarded December 23, 1966, to Universal Constructors, Inc., Albuquerque, N. Mex.

The Navajo Indian Irrigation Project is being constructed by the Bureau of Reclamation near Farmington in northwestern New Mexico for the Bureau of Indian Affairs.

Authorized June 13, 1962, this project is designed to divert water for irrigation from Reclamation's existing Navajo Dam and Reservoir to more than 110,000 acres of land. Lands to be irrigated lie within and adjacent to the Navajo Indian Reservation and will be developed for farming exclusively by the Navajo Tribe.

Over the years, the only agricultural use made of the land is livestock grazing. # # #

CLOUD-SEEDING EXTENDED IN HUNGRY HORSE BASIN

This creek flowing into Reclamation's Hungry Horse Reservoir is typical of the way the lake gets its water from snow-melt. In winter, cloudier skies make the area ideal for cloud-seeding.

The Bureau of Reclamation and the Bonneville Power Administration will conduct a winter cloud-seeding program in the Hungry Horse Basin of western Montana for the fourth consecutive year to augment stream runoff into Hungry Horse Reservoir.

Commissioner of Reclamation Ellis L. Armstrong said a contract with North American Weather Consultants, Inc., of Goleta, Calif., has been extended for operations during the 1969–70 winter season. Bonneville Power Administration, a companion agency in Interior with Reclamation, provided $53,883 for funding the work.

This cloud-seeding is part of the Bureau of Reclamation's Project Skywater, a program to augment water supplies through application of advanced technology.

Hungry Horse Dam, designed and built by Reclamation, is located on the South Fork of the Flathead River. Its powerplant produces hydroelectric energy which is marketed in the Pacific Northwest by the Bonneville Power Administration.

The operations area for the winter cloud-seeding program is the principal watershed for the 3.5 million acre-foot Hungry Horse Reservoir. Ground-based silver iodide generators located upwind of the basin are used to seed winter storms which meet carefully established criteria.

North American Weather Consultants has conducted seeding operations in each of the 3 previous years and reports on these operations have been made. Its operations headquarters will again be located at Kalispell, Mont. # # #

AMONG FIRST POTATOES AT NAVAJO FARM

Pleased with the red potato crop—92 percent f which are No. 1's—is Joe Gregory, agronomist t the San Juan Branch of the new Agricultural Experiment Station on the Navajo Indian Irrigation Project, being constructed in New Mexico by Reclamation.

Doing the digging is Rodney Gabehart, a tudent employee.

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has arried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form nay be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. DOCS.	

Enclosed find $______________ (check, money order, or Documents coupons). Please enter my subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents per single copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code______________________________

MAJOR RECENT CONTRACT AWARDS*

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6771	Missouri River Basin, N. Dak.	Oct. 3	Construction of stage 04 additions to Edgeley substation.	B & A Electric Co., Inc., Sacramento, Calif.	$219,713
DC-6775	do	Oct. 22	Construction of stage 05 additions to Fargo substation.	Electrical Builders, Inc., Valley City, N. Dak.	191,120
DS-6780	Central Valley, Calif.	Nov. 12	One hundred and seventy 10-, 12-, and 14-inch vertical flowmeters for Westlands Water District distribution system.	Emerson Electric Co., Brooks Instrument Division, Hatfield, Pa.	473,180
DC-6783	do	Dec. 2	Construction of city of Roseville water service from Lake Folsom.	Engineering Installations, Inc., San Francisco, Calif.	203,797
DS-6785	Colorado River Storage and Missouri River Basin, Colo., Wyo. and Mont.	Nov. 24	Furnishing parts and materials for modifying existing oil circuit breakers for Hayden, Curecanti, Shiprock, Archer, and Yellowtail substations. (Negotiated contract.)	McGraw-Edison, Power Systems Division, Canonsburg, Pa.	189,083
100C-1073	Columbia Basin, Wash.	Dec. 5	Construction of 28.5 miles of buried pipe and .7 mile open ditch drains for D82-4, -22, -39, -40, and -52 drain systems, Block 82.	John M. Keltch, Inc., Pasco, Wash.	549,848
100C-1082	do	Dec. 18	Construction of 5.8 miles of buried pipe drains for D43-79, -83, -212, and -213 drain systems, Block 43.	George A. Grant, Inc., Richland, Wash.	110,872
200C-780	Central Valley, Calif.	Nov. 20	Temporary riprap flood protection for siphons on the Friant-Kern and Madera canals.	R & D Watson, Inc., Johnsondale, Calif.	653,100
300C-293	Colorado River Front Work and Levee System, Ariz.-Calif.	Nov. 19	Construction and gravel surfacing of 4 miles of haul roads, construction of training structure embankments, and producing and placing riprap for bank protection and training structures for River Miles 591.5 and 596.2.	W. F. Whitlow, dba, Whitlow Construction Co., Riverside, Calif.	182,575
B600-22,927	Missouri River Basin, N. Dak.	Dec. 9	Furnishing riprap stone and rock spalls for Snake Creek embankment.	L. G. Everist, Inc., Sioux Falls, S. Dak.	471,925
604C-76	Missouri River Basin, Mont.	Oct. 24	Furnishing and placing buried asphaltic membrane lining for Helena Valley canal, Sta. 626+48 to 724+50.	R. J. Studer & Sons, Billings, Mont.	109,488
0 4C-77	do	Nov. 17	Furnishing and applying 2.22 miles of buried polyvinyl chloride lining for four reaches of East Bench canal.	Clark Brothers Contractors, Victor, Mont.	149,925

As the Nation's principal conservation agency. the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

U.S. GOVERNMENT PRINTING OFFICE: 1970 O—370-425

RECENT BID REQUESTS*

Project	Description of work or Material
[C]entral Valley, Colo.	Earthwork and structures, including 3 water screen and recirculating structures, for about 30 miles of 12- through 90-in.-diameter pressure pipe with heads varying from 25 to 75 ft; and furnishing and installing 13 pump units, including electrical equipment, with capacities ranging from 3.67 to 12.67 cfs. Westlands Laterals 29, 30, and 31, near Mendota.
Do	One each vertical, propeller or mixed-flow pumping unit per plant, each with a capacity of 100 cfs at total heads of 24.5 ft at Plant No. 1, 26 ft at Plant No. 2, 34.5 ft at Plant No. 3, and 52.5 ft at Plant No. 4. Contra Costa Pumping Plants No. 1, 2, 3, and 4.
[C]olo. Rvr. Front Work & Levee System, Ariz.	Constructing a lateral system to supply fresh water to Mittry Lake. The lateral system will consist of 30-in.-diameter concrete pressure pipe, 24-in.-diameter steel line pipe flume, and a concrete-lined ditch section. About 15 miles northeast of Yuma.
[C]olumbia Basin, Wash.	Excavation and concrete lining for one- and two-compartment tunnels, and two-compartment cut-and-cover conduit of about 2,400 ft in length for EHV cables; earthwork and construction of a reinforced concrete two-compartment cut-and-cover EHV cable circuit structure about 285 ft long; and grading for the cable spreading yard and the switchyard sites. Left abutment area of Grand Coulee Dam, 500-kv Cable Spreading Yard and 500-kv Switchyard.
Do	Constructing about 46 miles of buried pipe drains, Blocks 87, 88, and 82, east of Royal City, west of Othello, and west of Royal City.
Do	Constructing about 4,500 ft of gravel-lined open drain and installing protective drains for county road and railroad.
Do	Three 4,600-ft-lb oil pressure, electro-hydraulic, cabinet-actuator-type governors for regulating the speed of three 820,000-hp, 72-rpm hydraulic turbines for Grand Coulee Third Powerplant.
Do	Nine 500-kv power circuit breakers for Grand Coulee Third Powerplant 500-kv Switchyard.
Do	One centrifuge with filter-type or coalescing filter-water separator-type oil purifier unit with a capacity of 8,000 gallons per hour for Grand Coulee Third Powerplant.
Do	Four to eight electric, motor-driven, water-cooled, centrifugal, rotary wet screw, reciprocal- or sliding-vane type, stationary air compressors with a combined capacity of 12,000-cfm free air at 125-psi discharge pressure; two electric, motor-driven, water-cooled, double-acting, oil-free, reciprocal-type, stationary compressors, each with a capacity of 150-cfm free air at 125-psi discharge pressure; and two electric, motor-driven, water-cooled, three-stage, reciprocal-type, stationary air compressors, each with a capacity of 50-cfm free air at 1,200-psi discharge pressure. Grand Coulee Third Powerplant.
Do	One electric, motor-driven, two-speed, gear-type pumping unit with a capacity of 300 gpm at the higher speed and 50 gpm at the lower speed, at a discharge pressure of 100 psi; three electric, motor-driven, gear-type pumping units, each with a capacity of 300 gpm at a discharge pressure of 75 psi; and one electric, motor-driven, two-speed, gear-type pumping unit with a capacity of 32 gpm and 18 gpm at a discharge pressure of 100 psi. Grand Coulee Third Powerplant.
Do	Four electric, motor-driven, vertical-column, deep-well, turbine-type pumping units, each with a capacity of 16,000 gpm at a total head of 120 ft; two electric, motor-driven, vertical-column, deep-well, turbine-type pumping units, each with a capacity of 3,600 gpm at a total head of 100 ft; one electric, motor-driven, vertical-column, deep-well, turbine-type pumping unit with a capacity of 420 gpm at a total head of 150 ft; two electric, motor-driven, vertical-shaft, centrifugal-type pumping units, each with a capacity of 100 gpm at a total head of 60 ft; and one electric, motor-driven, vertical-shaft, centrifugal-type pumping unit with a capacity of 50 gpm at 130 ft total head. Grand Coulee Third Powerplant.
Do	Solid state and miscellaneous relaying equipment for Grand Coulee Third Powerplant 500-kv Switchyard.
[E]den, Wyo	Enlarging 70 turnouts from 6- to 12-cfs capacity; earth lining 7.7 miles of laterals; and enlarging 7.5 miles of laterals in the Eden and Farson Areas.
[F]ryingpan-Arkansas, Colo.	Earthwork and structures for 2 miles of 18-ft-wide, unsurfaced tunnel access road. Nast Tunnel, about 30 miles east of Basalt.
[G]ila, Ariz	Replacing about 7 miles of 28-in. through 38-in.-diameter pipe with 25 ft of head. South Gila Valley Unit Distribution System. East of Yuma.
[K]endrick, Wyo	Constructing a 3-in.-thick crushed-gravel base and a 2-in.-thick plant-mix bituminous surface 22 ft wide on about 5,800 ft of graveled access road over Alcova Dam about 30 miles southwest of Casper.
[M]issouri River Basin, Kans.	Constructing about 4 miles of buried pipe drain varying in size from 6 to 12 in. and grading and shaping about 0.9 mile of existing open drain. Bostwick 20–3–5 drain, near Courtland.
[M]issouri River Basin, Nebr.	Constructing about 1.3 miles of 8- to 12-in. subsurface drain varying in depth up to 10 ft, excavating about 0.4 mile for pilot channel, and improving 0.6 mile of drain channel. Bostwick 1–1–13, 10 miles west of Red Cloud.
Missouri River Basin, Mont.	Additions to the Yellowtail Switchyard will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing two 230-kv and one 115-kv circuit breakers and associated electrical equipment; and grading and fencing an extension to the area.
Missouri River Basin, Nebr.	Constructing about 1.5 miles of 8- to 12-in. subsurface drain varying in depth up to 10 ft and shaping about 0.6 mile of ditches. Franklin 2–1–11 drain, near Red Cloud.
Missouri River Basin, N. Dak.	Constructing about 15.4 miles of canal, with a bottom width of 25 ft, a water depth of 17.31 ft, and a capacity of 1,950 cfs; four bridges; and one check structure. Excavation cut will vary from 30 to 80 ft. Work will also include relocating about 10.5 miles of county road. McClusky Canal, Reach 3A, from about 5 to 20 miles south of McClusky, North Dakota.
Missouri River Basin, S. Dak.	One double-ended, outdoor unit substation consisting of a main supply of 300-kva, 3-phase, 13,200- to 240-volt, self-cooled transforming section on one end and an alternate supply of 300-kva, 3-phase, 13,200- to 240-volt, self-cooled transforming section on the other end for Huron Substation.
North Platte, Wyo.	Two 3,750-kva, 3-phase power transformers for Guernsey Powerplant.
Southern Nevada Water, Nev.	Work will encompass three schedules in one set of specifications. These schedules can be bid separately or in any desired combination. Unless otherwise specified, the pipe can be steel or reinforced concrete except that asbestos-cement pipe can be used for pipe 36 in. in diameter or smaller. Major items in schedules are as follows: Schedule I—Furnishing and laying pipe as follows: One mile of 96-in.-diameter, 5.5 miles of 90-in.-diameter, 1.6 miles of 72-in.-diameter, 4.7 miles of 66-in.-diameter, 140 lin ft of 36-in.-diameter and 0.4 mile of 24-in.-diameter; and 0.5 mile of 90-in.-diameter steel, 0.2 mile of 72-in.-diameter steel, and 1.6 miles of 66-in.-diameter steel; constructing three reinforced concrete bifurcation structures; one valve structure housing two 54-in. gate valves; seven rate-of-flow controllers ranging from 8 to 42 in. in diameter with gate valves downstream and motorized butterfly valves upstream; one reinforced concrete tank 75 ft in diameter and 22 ft high; one tunneled highway crossing; six reinforced concrete anchors; and air valve and blowoff structures. Schedule II—Furnishing and laying 4.4 miles of 36-in.-diameter pipe; and constructing four reinforced concrete anchors; one tunneled highway crossing; and air valve and blowoff structures. Schedule III—Furnishing and laying pipe as follows: 1.4 miles of 48-in.-diameter, 3.2 miles of 27-in.-diameter, and 0.5 mile of 24-in.-diameter; constructing three reinforced concrete anchors; and air valve and blowoff structures. Las Vegas Valley, Henderson, North Las Vegas, Whitney, and Sahara Laterals. From outlet portal of River Mountains Tunnel to the vicinity of Nellis Air Force Base with branch lines to Flamingo Reservoir, Sahara Terminal, and Henderson.
Do	Constructing Southern Nevada Pumping Plant No. 3, a 28.4-cfs, 4-unit plant consisting of a reinforced concrete substructure, 35 ft wide by 108 ft long; a 20-ft high superstructure of precast concrete panels and precast, prestressed roof members; a 38-ft-diameter, 32-ft-high reinforced concrete forebay tank, and a switchyard. Constructing pumping Plant No. 6, a 90-cfs, four-unit plant consisting of a reinforced concrete substructure, 44 ft wide by 118 ft long, a 27-ft-high superstructure of precast concrete panels and precast, prestressed concrete roof members; a 65-ft-diameter, 34-ft-high reinforced concrete forebay tank, and a switchyard. Work at each plant will include installing four motor-driven, double-suction, centrifugal pumping units; and furnishing and installing four hydraulic cylinder-operated cone valves, steel intake and discharge manifolds and four gate valves, one each 3-ton crane, 7.5-ton crane, 1,000- and 2,500-kva, 69–4.16/2.4-kv transformers, and associated electrical equipment. Work will also include installing automatic irrigation systems and landscaping at Pumping Plants No. 3, 4, 5, 6, and 7, and at Flamingo control station. Pumping Plant No. 3 is 8 miles and Pumping Plant No. 6 is 17 miles northwest of Boulder City.
Do	Furnishing and laying 127 ft of 120-in. monolithic concrete pipe with heads varying from 50 to 125 ft; 850 ft of 96-in. pipe with heads varying from 25 to 125 ft; 12,000 ft of 96-in. pipe with heads varying from 150 to 500 ft; constructing a reinforced concrete surge tank 28 ft in diameter and 58 ft high; a reinforced concrete regulating tank, 176 ft in diameter and 16 ft high; an earth dike; and appurtenant structures. Main Aqueduct, from west shore of Lake Mead west to inlet portal of River Mountains Tunnel.
Do	Furnishing and placing a buried cable system. Various locations along the Southern Nevada water distribution laterals northwest from Boulder City to Nellis Air Force Base.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

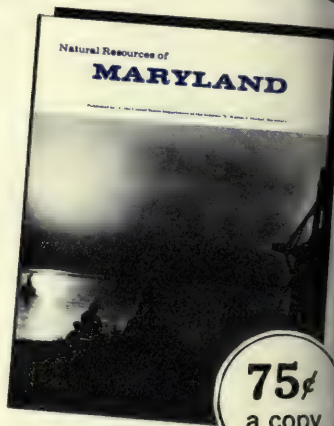
Natural Resources of . . .
MARYLAND

WATER • FORESTS • WILDLIFE • HISTORY • RECREATION • MINERALS

Whether your interests in this beautiful State are for travel, recreation, or general information, this booklet fits your needs. Generously illustrated and descriptively written, this publication takes the reader on a Statewide tour of scenic beauty, industrial development, varied natural resources, and recreational opportunities.

National and State parks are explored and historic sites are visited. Angler and hunter will learn of the fish and wildlife to be caught. For the student, this is a colorful introduction to the State's history, present development, and future progress. Published by the Department of the Interior, the booklet includes a summary of Federal programs devoted to natural resources.

Other Booklets In This Series Now Available: **MINNESOTA • NORTH DAKOTA MASSACHUSETTS • TEXAS • UTAH • IDAHO • WASHINGTON • SOUTH DAKOTA OHIO • ALASKA • OREGON • COLORADO • CALIFORNIA • ARIZONA • WYOMING WEST VIRGINIA • NEW MEXICO • NEVADA • MONTANA • INDIANA • PENNSYLVANIA**



75¢ a copy

Convenient order form with individual prices is provided

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS
RETURN AFTER 5 DAYS

POSTAGE AND FEES PAI
U.S. GOVERNMENT PRINTING

Name ....

Street address ....

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

Enclosed find $.............. (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

...... MINNESOTA. I 1.91:M 66	60¢
...... ALASKA. I 1.91:Al 15	65¢
...... TEXAS. I 1.91:T 31	45¢
...... ARIZONA. I 1.91:Ar 41	45¢
...... MASSACHUSETTS. I 1.91:M 38	45¢
...... COLORADO. I 1.91:C 71	50¢
...... OREGON. I 1.91:Or 3	50¢
...... NEVADA. I 1.91:N 41	45¢
...... CALIFORNIA. I 1.91:C 12	60¢
...... MONTANA. I 1.91:M 76	50¢
...... PENNSYLVANIA. I 1.91:P 38	65¢
...... MARYLAND. I 1.91:M 36	
...... WEST VIRGINIA. I 1.91:W 52 V	
...... OHIO. I 1.91:Oh 3	
...... WASHINGTON. I 1.91:W 27	
...... NEW MEXICO. I 1.91:N 42 M	
...... IDAHO. I 1.91:Id 1	
...... UTAH. I 1.91:Ut 1	
...... WYOMING. I 1.91:W 99	
...... SOUTH DAKOTA. I 1.91:So 8 D	
...... INDIANA. I 1.91:In 2	
...... NORTH DAKOTA. I 1.91:N 81 D	

Name ....

Street address ....

City and State .... ZIP Code

FOR USE OF SUPT. DOCS.	

May 19

RECLAMATION era

A WATER REVIEW QUARTERL

May 1970 Vol. 56, No. 2

RECLAMATION era

Gordon J. Forsyth, Editor

CONTENTS

Joy Gilleland is the artful water skier on Lake Powell of the Colorado River Project. See CRSP article on page 6.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGI

Big Non-Polluter

The remarkable old water wheel used long ago fo grinding wheat into flour was an ingenious use of th gravity pull of water. Falling water still is one of Man' most valued resources.

A modern wheel development, which makes mor efficient use of falling water, is the hydro turbine. Th turbine which has become a fabulous electric power pro ducer, has another great advantage—it does not pollute

In a time when there is nationwide alarm abou facilities which pollute water or air, the Bureau of Recla mation is making rapid construction headway on gigantic nonpolluter, an electric power "water wheel' system—the Third Powerplant at Grand Coulee Dam.

The turbines in Grand Coulee's two existing power plants have been pace-setters. They have handled billion of gallons of clean falling water from the Columbia River In turn, all of this water was still sparkling clean as i rejoined the downstream flows. The two powerplants pro duce electric power sufficient for 2½ million homes, bu they have not emitted any foul smoke or smells into th fresh, crisp air of Washington State since beginning operation in 1941.

When the Third Powerplant turbines begin operat ing in the next few years, even though their generating capacity will exceed that of any other such plant in the world, they still will not defile the amenities in the area.

Hydro plants actually remedy some pollution prob lems. When the flows gush out of the plant, natural aera tion immediately restores any lack of oxygen in the water, an essential for fish and animal life.

Stream sediment is a type of pollution. It is re moved or minimized in reservoirs located behind most Reclamation dams. The sediment settles to the bottom of the reservoir, leaving clean, clear water to flow through the gate openings of the powerplant. This results in better water for downstream areas.

Reclamation has built 51 hydro powerplants at its storage dams in the 17 Western States. These clean energy facilities, plus our multipurpose operations in 80 other flourishing project areas, set record-breaking contributions of wealth productivity for the Nation—and represent six decades of antipollution action.

ELLIS L. ARMSTRONG
Commissioner of Reclamatio

ciences meld for
nvironmental benefits

Jnique Studies for Reclamation—

WEATHER & ECOLOGY

AS we deepen our understanding of complex ecological processes, much more will be ossible," said President Richard M. Nixon in his nvironmental message to the Nation last 'ebruary.

Ecological processes are complex, as the Presi-ent stated. And Reclamation already is at work n the challenge—"much more will be possible" rough an understanding of the science of ecology.

A greater understanding of both ecology and eteorology is being gained simultaneously by the est scientists available through the Bureau of 'eclamation's test operations in weather modifica-on, or "cloudseeding" programs.

This results in a unique combination of sciences achieve needed development of dependable ater resources in areas of critical water shortage.

As defined by Webster, ecology is the study of ganisms (animals and plants) and their reaction environment. This field of study today is at-acting compelling waves of interest throughout e country.

Independent scientists working on Reclamation ontracts have been conducting tests on artificially ilking moisture from the "rivers of the sky" for lmost a decade. Some of the tests have produced gnificant increases in precipitation. Results are nalyzed each season, in the Bureau's offices in enver, Colo., and the experiences are coordinated eneficially into the next season's efforts.

;radual Change

A Bureau supported research team of ecologists ecently completed a study noting that any eco-gical changes resulting from cloudseeding efforts ould be apt to develop gradually. The changes animals and plant populations should be closely

Meteorologist at work on a Reclamation weather management program.

Mountains in Colorado near where the unique tests take place.

monitored, the team said, to determine both positive and negative effects.

This ecology team completed its report last fall. It was undertaken for Reclamation by Dr. Charles F. Cooper and William C. Jolly of the University of Michigan's School of Natural Resources. Dr. Cooper, on leave from the University, serves as program director for analysis of ecosystems for the National Science Foundation and is also a consultant to the National Water Commission.

Since completion of the Cooper-Jolly study, the environmental services operation of the firm of EG&G Inc., of Boulder, Colo., has been awarded a $1.8 million contract by Reclamation for a cloudseeding operational research pilot project in southwest Colorado.

To Achieve Balance

The cloudseeding effort and an ecological monitoring effort will be coordinated to achieve the best balance possible of results. In this Colorado area, before any cloudseeding is conducted, a plan for the monitoring program will be developed through a Bureau contract with three Colorado institutions—Colorado State University, the University of Colorado, and Fort Lewis College at Durango. As announced last February, these institutions will assign several scientific teams to complete development of the ecological monitoring program by next August on a $48,000 contract.

The basic purpose of the research effort, called the Colorado River Basin Pilot Project, is to determine whether cloudseeding operations can be used to augment existing water supplies in water-short areas of the Nation. An early requirement will be a survey of the cloudseeding target area's ecological resources in advance of seeding.

The cloudseeding contract by EG&G will be conducted under highly controlled conditions for at least four winter seasons, beginning in October 1970.

Target area for the pilot project is a 3,300-square-mile region in the San Juan Mountains which forms the headwaters for a number of streams and rivers tributary to the Colorado River. Its eastern border generally follows the Continental Divide north and westward from the Colorado-New Mexico border.

In the operations area there are four subareas, each with an assigned priority for seeding based on meteorological, physical, and social factors. The highest priority is assigned the Piedra River area; the lowest priority, the area north of the Molas Divide-Lizard Head Pass line. Seeding will be extended in order of priority, and only after study and evaluation of the significant factors as they apply to the different subareas.

Ecology Plan

The plan for the ecological monitoring program will be developed jointly by CSU's Department of Forestry and Natural Resources; by the University of Colorado's Institute of Arctic and Alpine Research; and by Fort Lewis College's Division of Biological Science. Before the ecological plan is submitted to the Bureau of Reclamation next sum-

ner, it will be critically and independently reviewed by a committee of ecologists to be named later.

Those responsible for the ecological monitoring will maintain close liaison not only with private groups having ecological interests, but also with State and Federal agencies, including the U.S. Forest Service; the Colorado Department of Game, Fish, and Parks; and the Colorado State Division of Natural Resources.

As part of the cloudseeding contract, EG&G is required to establish a program to appraise avalanche potential in the area of operations. The Bureau of Reclamation has, in addition, specified other criteria to provide safety overrides on seeding operations.

EG&G will accept responsibility for the operation of remote weather stations and a radio repeater system that have been installed in and around the operations area by Western Scientific Services, Inc., an early contractor for the Bureau's pilot project.

Seeding will be conducted on suitable winter storm clouds on a random 24-hour basis. Only those storms which meet certain criteria of temperature, humidity, moisture content, direction, and location will be eligible for treatment under this cloudseeding research activity.

The meteorological aspects of the pilot project were designed by Colorado State University's Atmospheric Science Department, which has designed and conducted similar winter cloudseeding activities for the State of Colorado and the National Science Foundation.

Results of the pilot project will be evaluated later, under separate contract.

Cooper and Jolly Report

The report by Dr. Cooper and Mr. Jolly is entitled: "Ecological Effects of Weather Modification: A Problem Analysis." Underlying theme of the study "is the need to apply human technology for the real long-term benefit of mankind."

The report considers all forms of weather modifications activities, although the Bureau of Reclamation, through its Project Skywater, is concerned only with the science of precipitation management.

Project Skywater, first authorized in 1961, is a program to develop scientific techniques to augment precipitation by cloudseeding for those areas of the country whose present and future growth is limited by inadequate water supplies.

Noting the frequently erratic pattern of natural precipitation, the University of Michigan study observes that "weather modification will be a change imposed on an already highly variable climate.

"This will make quick detection of its effects more difficult than if normal weather was identical from one year to the next. This problem will be accentuated by the normal, so far unexplained, fluctuations in species populations of many plants and animals on a wide variety of sites, upon which changes due to weather modification will be superimposed."

The study indicates that ecological effects of weather modification activities will be the result of moderate shifts in the rates of reproduction, growth and mortality of weather-sensitive species of plants and animals.

"Plant and animal communities change rather slowly in response to changed climate," it says. "The cumulative effect of slow year-to-year

Specialist using radar to track object in "skywater" study.

Tracing gas being released here will be studied at a distance.

changes in species abundance could be a rather extensive alteration of original condition, but the alteration could take place almost unnoticed by the general public."

The Report's Abstract

In its abstract the ecology report says:

"If deliberate modification of weather can be achieved, the structure of plant and animal communities will be altered through shifts in rates of reproduction, growth, and mortality of weather sensitive species. Ecological changes will generally require several years to become fully evident.

"Weather modification may interact with other ecological stresses such as air pollution and pesticide application to produce changes greater than the sum of the individual effects.

"The fallacious argument is rejected that because the change anticipated from weather modification is smaller than the normal variability of weather, weather modification will have little or no biological effect.

"Catastrophic outbreaks of weeds or insect pests are unlikely as a result of weather modification, but not impossible. Big game animals could be adversely affected if snow accumulation is significantly increased on winter range. Somewhat different effects are anticipated in semiarid and in humid regions.

"There does not appear to be an immediate serious threat of environmental contamination from silver iodide or other seeding agents. A global environmental monitoring system is urgently needed but adequate planning for such a system has not yet been done.

"A monitoring system should deal with all forms of environmental change, not weather modification alone. No research dealing specifically with ecological effects of weather modification has yet been reported.

"Agencies sponsoring research and development in the technology of weather modification have an obligation, which they have so far not adequately met, to support research to determine the social and biological consequences of this technology. Institutional arrangements may have to be altered to require such research support.

"The report includes sections on anticipated kinds of weather modification; effects in semiarid climates and in humid climates; pests and diseases; direct effects of seeding agents; biology of lakes and streams; fog, hail, lightning, and hurricane modification; environmental monitoring programs; inferences from ecological theory; recommended research; and recommended premodification field surveys."

The 160-page report is available by purchase through the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151.

Reclamation confidently accepts the challenge—unique but inevitable—that of studying the effects of the weather management program and adapting it satisfactorily to the ecological forces of nature for the long range benefit of all. # # #

WATER Quiz

[1] Which figure below is right for the number of boats on this stretch of the Sacramento River below Shasta Dam, Calif.?

(a) 44
(b) 45
(c) 46

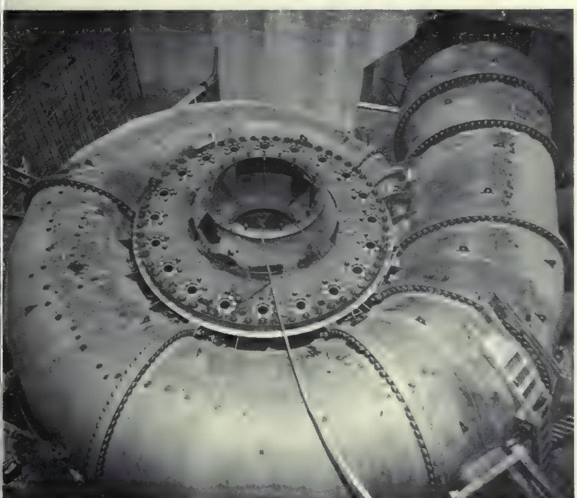
[2] How many dollars for constructing Reclamation projects have been repaid to the U.S. Treasury through 1968?

(a) $1 billion
(b) $2 billion
(c) $850 million

[3] What percentage of the Reclamation construction costs are being returned to the Treasury?

[4] Which type of recreation is most popular at Reclamation lakes?

(a) fishing
(b) boating
(c) sightseeing
(d) camping
(e) swimming



[5] Why is such a photograph as this about the only way visitors will be able to see the huge "snail" (scroll case) at a hydropower plant? This pipe is the waterway which transports the gushing flows to the turbine blades at Reclamation powerplants.

(ANSWERS: 1.—(b) 45; 2.—(a) $1 billion; 3.—About 89 percent; 4.—(c) sightseeing; 5.—Solid concrete is encased around it for added strength against gushing water.)

Reclamation grows in Colorado basin

PAYOFF SOARS IN BASIN PROJECT

THE Colorado River Storage Project has achieved outstanding progress since it began operation in 1963.

Assets of the project had reached a total of $837.2 million as of June 30, 1969. Gross revenues during fiscal 1969 amounted to $21.9 million.

In view of these figures, the project's future production holds high promise for people in many fields of endeavor.

Large populations of seven States are directly or indirectly benefitted by the CRSP. The seven favorably affected are Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

This multipurpose project delivers electric power for homes and industries, and water for both metropolitan and farm uses. The construction include s facilities for extensive lake recreation, and enhancement of fish and wildlife.

Last year four powerplants at CRSP dams generated sufficient power during periods of heavy customer use to meet the equivalent full-day needs of more than 800,000 homes. Actual revenues from power sales in fiscal 1969 totaled a significant $19.8 million—income from 4 billion kilowatt-hours of generation.

The powerplants are at four dams, Glen Canyon, Ariz.; Flaming Gorge, Utah; Blue Mesa, Colo.; and Fontenelle, Wyo.

Seventy-five percent of the power produced on the project took place at Glen Canyon Dam where eight large turbines operate. This facility generated 3 billion kilowatt-hours.

Other power was from Flaming Gorge with 684 million kwh; Blue Mesa with 258 million kwh; and Fontenelle with 67 million kwh.

Arizona was the highest user of CRSP power at 37.7 percent. Utah used 26 percent. New Mexico used 13.6 percent. Colorado used 12.9 percent. Nevada used 4.5 percent. California used 3.3 percent, and Wyoming used 2 percent.

wo New Plants

The population in this area is growing faster han the national average, so to help meet the denands for power, such facilities will increase durng the next few years, and new plants to be added vill include Morrow Point and Crystal Dam in Colorado, and 3 dams on the Central Utah Project.

About 74,000 acres of land are now being served vith water from CRSP facilities, and crops from his land are valued at about $5½ million for the ear.

CRSP lakes, some of them attracting visitors rom throughout the Nation, are used more each ear for recreation. There were 3.4 million visits ast year (1969). The increase was 5 percent over he year before at the 12 CRSP reservoirs, with he largest gains showing at Lake Powell behind Glen Canyon Dam, and Blue Mesa Reservoir.

At Lake Powell an access highway was completed in 1968 to the Bullfrog Basin recreation ite. Bullfrog is located along the upper part of he reservoir and is about 100 miles closer to Salt Lake City, Utah, than the Wahweap site in Arizona. Basic recreation facilities are nearly ompleted at Bullfrog Basin.

ecreation Facilities

Construction is continuing on basic recreation acilities at the Elk Creek and the Iola area at Blue Mesa Reservoir. Camping and picnicking acilities were added along with a better access oad and parking areas.

Year 1969 was only the third full year of use t Blue Mesa, but with the added facilities about 34,000 more visitor days were recorded than in 969.

Flaming Gorge Reservoir was again the most opular and heavily used recreation area of the CRSP. It sustained nearly 1.2 million visitor-days which is far above the early estimates made for he area at its present stage of development.

Fishing is reported good in all project reservoirs nd it has been exceptional at Flaming Gorge and Navajo Reservoirs.

A successful fish stocking program has been arried on by the Bureau of Sport Fisheries and Wildlife and by the various State fish and game agencies. Release of clear cold water from the eservoirs has also created an extraordinary tream fishery below most of the dams.

F & W Enlargement

Fish and wildlife programs will result in major new benefits in this region. Two fish hatcheries had been substantially completed with funds of the CRSP Act.

Jones Hole National Fish Hatchery is located below Flaming Gorge Dam. It is still under construction, but the administrative buildings, residences, and the hatchery facilities were in operation last year. The first rainbow trout eggs were received at the hatchery.

Tall corn grown by irrigation on part of CRSP in Colorado.

Hotchkiss National Fish Hatchery is located near Hotchkiss, Colo. The Bureau of Sport Fisheries and Wildlife approved this facility for operation.

A National Wildlife Refuge and three waterfowl management areas are being developed in connection with the Colorado River Storage Project.

Development of the Seedskadee National Wildlife Refuge has begun along the Green River below Fontenelle Reservoir and will continue over the next several years. A land acquisition program is underway in this area to purchase some 7,400 acres to be used in conjunction with other publicly owned land.

Waterfowl Management

Browns Park Waterfowl Management Area is located below Flaming Gorge Reservoir in Utah. A residence, shop, and bunkhouse have recently been completed. About 30 acres of land have been planted to millet, strawberry clover, and winter wheat to provide feed for the migrant and permanent bird populations.

This Browns Park area has been stocked with some geese, ducks, and pheasants to increase local populations of these birds.

Miller Mesa Waterfowl Area on the west shore of Navajo Reservoir just south of the Colorado-New Mexico border is about complete. A small reservoir and dikes are completed and full. About 170 acres of agricultural land have been planted to barley, oats, wheat, and alfalfa.

Some work began during fiscal 1970, with nonreimbursable funds obtained through the CRSP Act, on Desert Lake Waterfowl Management Area. It is located in eastern Utah near Huntington North Reservoir. Purchase of about 280 acres of land is planned in addition to that already being developed by the Utah Division of Fish and Game. Preliminary plans are in final form for the development of this area.

Joint fishery investigations for Lake Powell have continued by the Arizona and Utah fish and game departments, and at Flaming Gorge Reservoir by the Utah and Wyoming departments.

The 6-year studies of these organizations are being extended beyond the original completion date. Due to the continuing needs of fishery management and the desirability of an efficient transition of the anticipated workload, a 3-year extension has been proposed during which the States are to assume a progressively increased share of the pertinent costs.

To Sustain Quality

Objective of the organizations is to obtain the basic management data needed to sustain the out-

Artist Dean Fausett paints scenic lake lighted by setting sun.

standing fishing quality already developed at these reservoirs.

A contract was awarded for the third segment of the 6-year game and fish study at the Curecanti Unit complex of Blue Mesa, Morrow Point, and Crystal Reservoirs. This work is being conducted by the Colorado Division of Game, Fish, and Parks.

A modified contract was awarded for two fishing lakes (Dome Lakes) on Archuleta Creek to adjust to an anticipated increase in construction costs.

Five new multipurpose water projects were authorized by the Colorado River Basin Act that was signed by the President in September 1968. These projects, all in western Colorado, are the Animas-La Plata, Dolores, San Miguel, West Divide, and Dallas Creek Projects.

The act specifies that those projects must be constructed concurrently with the Central Arizona Project, also authorized by the act.

On the phases of the CRSP still under construction, work is continuing on the Bonneville Unit of the Central Utah Project, the Bostwick Park Project and Morrow Point Powerplant in Colorado, the Lyman Project, in Wyoming, and the Navajo Indian Irrigation and San Juan-Chama Projects in New Mexico.

The Bureau of Reclamation expects that the reimbursable Federal investment in the CRSP will be repaid to the Treasury well within the alloted time span.

It is a huge program, and it holds promise of fabulous benefits which are known to be possible by the results of other Reclamation developments, and by the successful results of the CRSP's own 7 years of operation. # # #

378-987 O—70——2

Gadget looks like firehose nozzle

CUT BACK ON COOK-OUTS

by GORDON J. FORSYTH
Washington, D.C.

A GADGET for measuring stresses in dams—but which needed expensive overhauls including many hours of drying-out time in an oven—does not need the oven any more.

A Bureau of Reclamation employee solved the highly sensitive gadget's problem.

The instrument, or gage, which looks like the nozzle to a firehose has been available only a few years. It is an important aid in the building and upkeep of large structures with deep foundations such as dams.

The problem of water penetrating to the instrument's hair-like electrical segments had been a constant source of trouble. Scientists developed the gage (transducer) to register stresses or shifts in masses of earth or concrete.

Although it had been waterproofed, the gage sprung leaks 75 percent of the time because of the watery environment in the deep holes bored for its use in mass earth or concrete. Even a slight amount of water penetrating to the electric parts during the few hours it is in the hole was causing the gage to go dead from short circuiting.

Solution to the gage's leakage problem was a tough neophrene rubber cover finally developed by Joseph W. Fabry, Jr., a structural engineer at the Bureau of Reclamation's research center in Denver, Colo.

Before Fabry's sheath-type cover, the gages which had collected moisture inside required a minimum oven-drying period of 2 days, and usually an additional 3 days to repair the weakened waterproofing it formerly had.

Better Than Expected

Critically tested in Reclamation's Denver laboratories, the new waterproof cover surpassed all expectations for reliability. An exemplary on-the-job performance was at the proposed Raccoon Mountain Powerplant, a TVA site, where a Bureau of Reclamation crew on a special assignment needed only one of the newly covered gages.

Before Fabry's discovery, an average of six instruments would have been needed, or an additional 144 hours of drying in a hot oven.

"This discovery by Mr. Fabry," said Reclamation Commissioner Ellis L. Armstrong, "plus the special electric plug he fashioned for this important instrument, are examples of the advanced thinking and creativity shown by many Reclamation employees. I am sure these two efforts alone will prove very valuable to engineering and construction agencies both in and out of the Federal Government."

Fabry's other gage device mentioned by Commissioner Armstrong is a new plug which saved about $13,000 during 1 year of use. Only 15 minutes is now required to reconnect the electric cable to the gage whereas the former direct wiring method needed 4 days to make the reconnection. Such reconnection is required often because either the gage or the cable frequently are damaged by falling rocks.

# # #

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

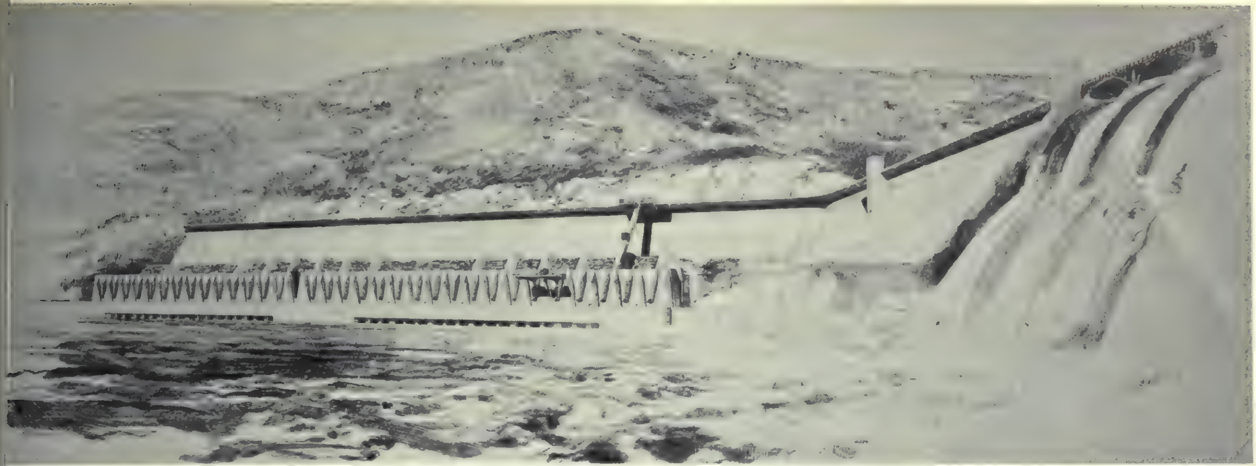
UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)

IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
7th & Taylor
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225



Drawing of the new forebay dam and third powerplant.

Milestone of Progress—

$112 Million Contract For Third Powerplant:

RECLAMATION'S LARGEST —WORLD'S LARGEST

THE largest Bureau of Reclamation contract ever awarded—over $112 million for construc-ion of the giant Third Powerplant and Forebay Dam at Grand Coulee Dam, Wash.—was awarded ast February 26.

The significance of the contract was noted in Washington, D.C., with signing of the agreement by Interior Secretary Walter J. Hickel. Also pres-ent were Assistant Secretary—Water and Power Development, James R. Smith, Reclamation Com-missioner Ellis L. Armstrong, and officials of the contracting companies.

"We are intent on making the Grand Coulee Dam and power installations an example of man's finest work," Secretary Hickel said. "The Colum-bia River, one of nature's great resources, has been turned to the enrichment of civilization."

The construction project was exempted from the President's reduction of spending for public works, because of the urgent schedule to meet power needs in the Pacific Northwest and to ful-fill commitments of the Columbia River Treaty with Canada.

Installation of the added power capacity was made possible by added upstream storage capacity in Canada and construction of Libby Dam on the Kootenai River in the United States.

The Third Powerplant in its initial stage will house six enormous hydro-turbines and generators each with a capacity of 600,000 kilowatts, the largest in the world. To contain these mammoth units, the powerplant building will be the equivalent of 20 stories high, 1,128 feet long and 217 feet wide. The first three of these units are now being built under contracts totalling more than $41 million awarded in 1968.

Twelve Eventually

The forebay being constructed along the right abutment of Grand Coulee Dam will be built of a size sufficient to accommodate eventual expansion of the new Third Powerplant to contain an additional six hydro-turbines of the same size. Only the initial six units are presently authorized by the Congress.

"With the installation of the initial six units in the Third Powerplant," Commissioner Armstrong said, "the generating capacity of the Grand Coulee power complex will be increased from its present 2,042,000 kilowatts to 5,642,000 kilowatts of capacity."

Eventually, with the authorization and installation of the second six units, Grand Coulee's total generating capacity will be 9,242,000 kilowatts, far larger than any power generating facility now existing anywhere in the world.

"It will be of enormous benefit in meeting the power needs of people and industry in the Pacific Northwest and elsewhere," added Commissioner Armstrong.

"Everything about this Third Powerplant installation is so large as to be nearly unbelievable," said Commissioner Armstrong, "and it is certain to take its place as one of the great wonders of the modern engineering world, as was the original Grand Coulee Dam at the time it was constructed in the 1930's."

Huge Sizes

As an example of the unprecedented sizes we are dealing with, the penstocks that will take water from the Forebay Reservoir to spin the turbines will be 40 feet in diameter. Each penstock will serve its units with 30,000 cubic feet of water every second—about twice the average flow of the Colorado River through the Grand Canyon.

As another example, the turbine shafts that will spin the generators will be about 7 feet in diameter, dwarfing the largest such shafts we now have—those at the existing Grand Coulee Powerplant, which are 3 feet, 8 inches in diameter.

Work under the contract includes construction of a concrete forebay dam, six 40-foot-diameter concrete-encased penstocks, the Third Powerplant structure itself, visitor facilities, and service roads and service yards.

The contract for construction of the Third Powerplant and Forebay Dam goes to the joint venture firm of Vinnell Corp., Alhambra, Calif.; Dravo Corp., Pittsburgh, Pa.; Lockheed Shipbuilding and Construction Co., Seattle, Wash.; and the Mannix Construction Co. Inc., Calgary, Canada. The bid, the lowest of four received, compares with an engineer's estimate of $109,386,404.

Forebay Extension

The Forebay Dam will be a gravity-type structure with a maximum height of approximately 200 feet above the foundation. It will be virtually an extension of approximately 1,275 feet, at an angle from the existing dam which has been breached at the right abutment and is now protected by a coffer dam where excavation work has been carried on under a separate contract.

Galleries through the existing dam and a tunnel and a section under the south service yard will be constructed to carry extra-high voltage conductors between the Third Powerplant and the spreading yard high above the abutment.

The existing and new structures will be void of any surface transmission lines or towers. Two service yards adjacent to the Third Powerplant will be constructed, as well as 2.8 miles of roads. A retaining wall will be constructed along Marina Way in the Forebay area.

The architectural features of the Third Powerplant were designed by the world-famous architect Marcel Breuer and his associate, Hamilton Smith, of New York City. In addition, a proposal for environmental upgrading of the total Coulee Dam complex including the several surrounding communities has been developed by the architectural firm of Kenneth W. Brooks of Spokane, Wash.

\# # #

More beautification on Reclamation project

Well, How Does it Look?

A WELL structure doesn't have to look like one, and the Salt River Project is spending $55,000 a year to prove it.

A high price to pay to beautify the project's well system? "Not when you realize the modern structures now being built carry the same price tag in the long run as chain-link fences erected years ago," says Carl Sparks, Supervisor of the Groundwater Design Division.

Decorative redwood gates and attractive arched panels of natural stone and tinted concrete are used in the new mode.

In 1966, as part of the Project's Community Styling Program, the groundwater division staff took a good, long look at well sites and tried to devise a way to improve their appearance.

Today some 30 locations have been constructed or renovated as a result of their efforts.

"When the wells were drilled, our main concern was getting water to our customers with the lowest practical plant investment. But as communities grew around these sites, we realized something had to be done to make them look pleasing as well as functional," said Sparks.

Cost was a big factor in the number of sites that could be beautified. It was impractical to replace all the existing structures, but as plans developed for new sites, specifications were made for modern hydro-styled structures.

The first such structure was of red concrete panels that could be lifted out to be moved or replaced.

Moving Factor

"The ability to move these sections and use them in other locations was a big factor in equalizing costs compared to the old chain-link fences," explained Sparks. "It would cost us as much to tear down one of the chain-link fences and replace it as it does to build one of our newer designs."

Although the concrete panels of the first effort

Gentle arch stone wall and wood slats conceal a well pump.

Appearance of this well feature is enhanced for passing motorists.

People in this residential area have about forgotten this pump site exists after it completely disappeared behind a decorative fence.

were an improvement over chain link, Associate General Manager Henry Shipley directed a wellsite structure be built with natural rock veneer and, at the same time, be economical.

Karl Blume, Civil Design technician, was one of the men responsible for turning Mr. Shipley's request into mortar and stone. "The beautification program gave us a chance to be artistic and create something different than the square-box types we had been building," he said.

By memos of Dick Juetten, Hydraulic Engineering Department Supervisor, the straight lines of the first panels gave way to graduated arches and the plain concrete was replaced by natural stone.

Sparks credited Shorty Lemons with the actual casting of the beautiful panels as well as the award-winning suggestion to cast the larger panels.

All of the panels and posts for the well sites are cast at Southside C&M, reducing the cost of the panels when installed to approximately $14 a linear foot.

Panels Cast

"A main consideration in the design was to keep the panels a size that we could cast ourselves rather than hire someone else to do it," explained Lemons. "We have managed to keep the weight down to 3 tons per panel, yet it still takes experienced men to haul the panels around."

Four panels are poured at one time in large molds at Southside C&M. The rocks are selected and a pattern is planned for each slab. After the mortar begins to thicken, the rock design is then transferred into the forms.

"We have only a few hours to get all the rocks perfectly arranged before the mortar gets too hard, and special care is necessary to create a perfectly flat surface," said Lemons.

In addition to the panels, line, end, and corner posts are poured at the yard. The result—a complete precast wellsite enclosure is available when Carl Sparks drafts a work request.

"We are planning to beautify seven of our existing wellsites in the next year in addition to any new structures that will be built," said Sparks.

The supervisor's dilemma is choosing the seven sites that will get the facelifting. Sparks receives many requests from people explaining why the wellsite in their neighborhood should be first on the list.

"We try to find the site that is in the poorest condition, yes, but also give consideration to locations that are heavily populated, near a major highway, or must be relocated as a result of city growth."

Carl Sparks pointed to a series of colored pins on the project map in his office. "You probably didn't know there were that many wells in our system. That's what we're trying to do—build well features which no one will recognize, even when they drive by them."

# # #

Giant Vacuum for Big Jobs

by GRANT R. LAMB, Reclamation Office
Provo, Utah

A GIANT mud and rock sucking vacuum cleaner is being used to remove debris from Water Hollow Tunnel in Utah. The powerful machine is a valuable innovation, according to Palmer B. DeLong, Bureau of Reclamation's Project Manager of the Central Utah Project where the tunnel construction is underway.

A suction boom attached to the front of the vacuum car has an 8-inch diameter hose which sucks up about everything it touches—rocks up to the diameter of the hose are gobbled up.

With two men operating the vacuum, it can do in 4 hours what formerly required about 18 men up to four 8-hour shifts to do.

Drilling of the 4.1-mile-long Water Hollow Tunnel, which is a feature of the Bonneville Unit of the CU Project, is being done with another recent labor-saving tunneling machine, the "mole". Once a week the "mole" is stopped, reinforcing steel is installed, and the floor of the tunnel is housecleaned with the vacuum, better than tunnel floors ever were cleaned before.

In the past the pickup step had been a laborious, time-consuming hand operation. The new machine already has proved its worth in this particular tunnel.

Progress of the rock-chewing "mole" in Water Hollow Tunnel was temporarily halted because of excessive rocks falling from a fault in the mountain. Water also flowed out of the crevasses at the rate of about 700 gallons per minute.

Sucks Up Rocks

Picking up this loose material by hand, especially from between the steel tunnel supports, is a difficult or impossible job. However, the vacuum cleaner experienced no problem in sucking up both rocks and water so the "mole" could proceed.

The large vacuum is a creation of Boyles Brothers Drilling Co. of Salt Lake City, Utah, who is drilling the tunnel on a Reclamation contract for $5.6 million. Company officials feel sure the vacuum cleaner will result in some savings in the construction cost.

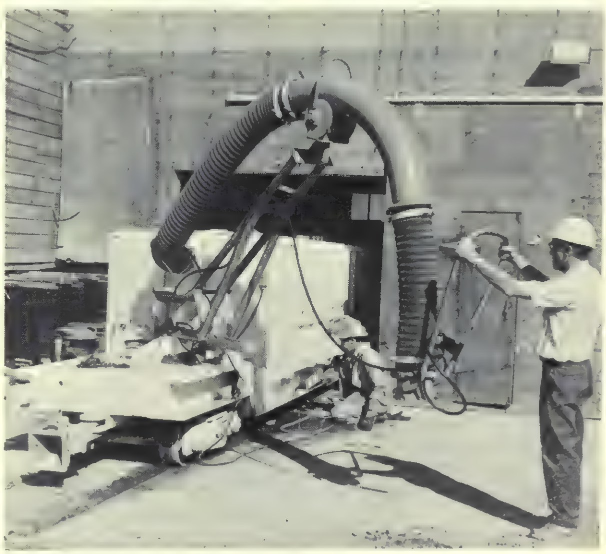
Idea for the powerful vacuum is from a large street cleaner seen sucking up leaves and debris from city streets and gutters.

Paul Sherrick of the construction company designed the machine. It was built in the company's shop for about $28,000, which is a savings of about $50,000 from what would have been the price to buy the machine from another firm.

A 200-horsepower electric motor drives two large fans which create the powerful suction for the cleaner. It is mounted at one end of a vacuum box 4 feet wide, 4 feet high, and 25 feet long on railroad wheels so it can be taken into the tunnel. The boxcar will hold 10 tons of vacuumed material.

# # #

The vacuum nozzle is being held by the man at right.



Big new efficiencies at less than $5 per acre

Irrigation Guesswork—Goodbye

by NELLO CASSAI, Information Officer
Denver, Colo., Region 7

THE computer, which regulates the lives of many, may soon become a common tool of the irrigation farmer.

The machine will tell him when and how much to irrigate in order to produce maximum crop yields with a minimal use of water.

The Bureau of Reclamation's Region 7 in Denver has just completed field studies with promising results. Interested farm groups in Nebraska, Kansas, and Wyoming are asking for details.

One test included 363 acres on two farms near McCook, Nebr., and another was a 260-acre area on three farms near Torrington, Wyo.

The date for the next irrigation? The amount of water to be applied in inches? Guesswork on such questions is being eliminated by a computer at the Kansas River Projects office, McCook. The information, along with daily climatic data, was listed on a computer printout sheet—which was furnished to irrigators the first of each week.

Fred C. Corey, water use study supervisor of Region 7, observed:

"Importation of water from Canada and Alaska may provide increased water supplies in 25 to 50 years, but something has to be done meantime to improve the efficiency of water applied today.

"This computerized water management program appears to be one of the answers."

Corey stressed that the Bureau did not originate the program, that the real pioneer was Dr. Marvin E. Jensen, of Twin Falls, Ida., director of the Snake River Conservation Research Center, Department of Agriculture.

Devised by Jensen

"He devised the program a couple of years ago but we developed our own technique on land irrigated by Bureau facilities," Corey said.

Tests similar to these of Region 7 were conducted last year by the Bureau's Region 1 near Burley, Ida.

Just what information goes into the computer? How is it collected?

Basic data on five problems are required to start a computer analysis. They are moisture-holding capacity of the soil, effective rootzone depth, infiltration rates (how fast the water percolates into the soil), type of crop being produced, and the amount of soil moisture depletion.

Daily data included maximum-minimum temperatures, solar radiation and effective precipitation (how effective was the last rain?).

Runoff from the fields was automatically recorded through instrumented flumes. Moisture levels in the soils were measured with electrical resistance blocks located at both the upper and lower end of the rows at several locations in the fields.

Bureau employees gathered all of this data and fed it into the computer.

Tremendous Step

"This scientific approach, eliminating the guesswork, is a tremendous step in irrigation," Corey said. "Farmers generally know how to irrigate but they don't know exactly when to irrigate.

"Many, in fact, still time their irrigations as they did 25 years ago—and not according to crop-soil and climatic factors, which vary from day to day.

"Some farmers irrigate by the calendar, others under fixed rotation schedules, and still others irrigate when their neighbor does. When the crop shows some stressing it is too late to assure maximum yields. Time to order the water and time to finish the field must be considered when deciding when you must irrigate a particular field."

The Wyoming-Nebraska irrigation scheduling

programs were discontinued last fall after a 1-year effort and it is not known when funds will be provided for another study.

Corn was the principal crop grown on the tests near McCook. In Wyoming sugar beets, beans, and corn, plus alfalfa and small grains were tested.

Nat Tolman, Region 7 supervisor of land and water operations, said the service—since it was so enthusiastically accepted by the farmers—could be continued by a commercial company or better still, the irrigation districts.

He said a program serving a large number of acres could be handled by one good technician and perhaps four or five college students with a knowledge of agriculture.

Two types of irrigation management services could be available to the irrigator on a voluntary basis.

Under one type, an agriculturist would visit the irrigator at a specified time on a weekly basis. Recommendations made by the computer would be checked by field observations and field probing, and the irrigator would make the final decision as to when to irrigate.

The agriculturist might also be asked to check for insects, disease and soil fertility.

$1.50 to $4

Specialists say that costs for this type of service might range from $1.50 to $4 an acre.

Under the second type of service the weekly computer printout would be mailed to the farmer, who would couple the scientific information with his own field observations. The cost of this service should be less than $1.50 an acre. Under this procedure the irrigator would relay pertinent climatic information to the agriculturist by telephone or postcard.

Questions that naturally arise are: Did the Bureau's recent activity increase crop yields? And if so, how much?

As one robin doesn't make a spring, neither does one experiment produce conclusive results.

Arvene Myers, owner of one of the farms near McCook, said he realized a total yield of 155 bushels per acre of corn, an increase of 35 bushels over his 1968 yield.

Myers was quick to point out, however, that he did not attribute all of this increase to scheduled irrigation, explaining that at least part of this was due to the absence of stalk rot disease which struck his 1968 crop.

Technician's Worry

As important as the increased yield, Myers said, was the peace of mind he enjoyed by letting trained technicians worry about when to irrigate.

He said the program also enabled him to devote to other chores and pursuits the time he normally would have spent inspecting his soil and crops.

Robert Wallen, another of the McCook farmers, said the program provided still another benefit in that it served as a guide in irrigating lands outside the study plots.

And significantly, Corey's figures showed water

This sol-a-meter measures radiation from the sun and other data.

(Photo by McCook Kaily Gazette)

Demonstration being watched here is surface runoff which is measured continuously by the fiberglass flume and A—35 recorder.

savings of 10 to 15 percent under the 1968 season usage.

Almost no water was allowed to seep below the rootzone, lessening the prospect of future drainage problems.

That's the name of the game, of course—efficiency. Surface irrigation efficiencies in general today range somewhere between 30 and 45 percent while most of us agree they should run 60 to 70 percent under reasonable conditions and without additional labor.

Supervisor Corey said: "The big problem is not surface runoff losses, but the hidden deep percolation losses. With an understanding of crop-soil and climatic conditions and scheduling irrigation at the proper time, this loss can be reduced to an acceptable level."

Runoff Needs

"I'm not saying that runoff losses need not be improved," said Mr. Corey. "With these losses averaging 20 to 40 percent, it may be well to consider a pump-back system in addition to controlling deep percolation losses."

A good pump-back system could raise efficiency to perhaps 90 percent.

But can a bunch of dirt farmers afford a computer?

An irrigation district or a commercial or private firm could install a computer console in their offices and handle 30,000 to 40,000 acres of scheduled fields for less than $4,000 a year—between 10 and 13 cents an acre. To these computer costs must be added the administrative costs, which would bring the total to about $1.50 an acre.

In addition to scheduling irrigations, such a firm could also computerize other farm functions. Under this program, the farmer could:

1. Reduce his costs of water and labor by having fewer irrigations.

2. Lower fertilizer costs by holding loss of nutrients to a minimum.

3. Increase net returns by increasing crop yields.

4. Prevent water logging of the rootzone and controlling salinity.

5. Gain additional returns from noncash crops, which normally are stressed in water short areas.

Like other stepped-up programs in this country resulting from computer operation, farmers will be saying goodbye to irrigation guesswork. # # #

FIFTY YEARS AGO
in Our Magazine

MILLIONS FOR MOISTURE.

United West Indorses More Liberal Policy for National Reclamation of Arid Lands.

In response to a call by Governor D. W. Davis, of Idaho, delegates approved by the chief executives of 13 western States met in Salt Lake City, Utah, November 21–22, and perfected a permanent organization to be known as the Western States Reclamation Association.

The purpose of the association, as stated by Gov. Davis and as written in the proceedings of the conference, is to properly present to Congress and the Federal departments a broad, comprehensive, and unified plan for the development of the public domain and the utilization of the flood and waste waters of the western streams for irrigation and power under cooperative Federal and State supervision.

The response to the call was enthusiastic, 156 delegates and alternates being in attendance. In addition many prominent western citizens were present during the sessions.

Gov. Davis was made presiding officer of the conference. He told of the advantages that have accrued to the West as the result of reclamation, stating that reclamation of arid and swamp lands is no longer an experiment, but a proved system. The records of the railroad companies for the past year show that the Twin Falls (Idaho) project, costing $12,000,000 to reclaim, has shipped out $42,000,000 in agricultural products, while the Yakima (Wash.) project, costing $14,000,000, has shipped out $54,000,000 in agricultural products.

The Ice Harvest.

Each year dairymen lose thousands of dollars from returned sour milk, poor butter, and low-quality cheese. They should take advantage of any near-by lake or stream to obtain a supply of ice for next year.

ICE COSTS LITTLE.

The ice-harvesting season fortunately comes at a time when there is the least work on the farm for men and teams, and consequently the actual money cost is usually not very great.

The quantity of ice needed depends upon the location of the farm—whether in the North or in the South, the number of cows milked, and the method of handling the product. In the Northern States it has been found that, with a moderately good ice house, one-half of a ton of ice per cow is sufficient to cool cream and hold it at a low temperature for delivery two or three times a week. One and one-half or two tons per cow should be provided where milk is to be cooled.

NOTED HERE AND THERE.

Arizona, Salt River project.—What is believed to be the top price for ranch land was reached recently when E. E. Morrison sold his 40-acre ranch to J. W. Dobson for $525 per acre. The deal was a cash transaction, Mr. Morrison receiving $21,000.

This place is just on the edge of the proposed incorporated town of Chandler and only has an average amount of improvements, including a small house, hay barn, corrals, and fences. It is excellent soil. The purchaser is a brother of J. H. Dobson, and has been visiting here from Canada for several weeks.

Perhaps one reason why lands are bringing high prices in the Chandler district is due to the amount of hard cash derived from them, and while cotton is still king, it is not always that staple that produces the most revenue.

Below is the experience of Roy Wood, pioneer Chandler rancher, who has realized a small fortune this year from grains, all of the $7,252 net profit coming from 32 acres of land. Mr. Wood can tell his story better than the writer, and this is it:

"In January I planted my 32 acres to wheat. I had been sick with the flu and had been unable to get anyone to do the farm work, so I hitched my disk to the back end of my Oldsmobile and disked in the seed. On April 17 I gave the land one good irrigation, about an acre-foot of water. In June I took off 266 sacks of wheat, for which I received $1,500.

"I let the alfalfa come along then and in the meantime took a trip to the Grand Canyon. In August I thrashed 13,900 pounds of alfalfa seed and sold it for $2,670. In October of this year I took off a second crop of seed—some 10,900 pounds—which is worth $2,402. I still have 150 tons of alfalfa and wheat straw on the place, for which I have been offered $12 a ton, but to be conservative will value it $1,000. I still have my land left for pasture for the rest of the year, which should bring in several hundred dollars, which we will not figure in the sum total.

"Now adding up my receipts give me a total of $7,662. My farming expense for these operations, including seed, thrashing, and water, amounts to $410, leaving a clear profit of $7,252."

Nebraska-Wyoming—North Platte project.—

To Morrill and Scotts Bluff Counties comes the honor of establishing an entirely new world's record in price paid for a Hereford bull, less than a year old, this same record being made at the John Heinz and John Burson sale of Herefords which took place at the sale pavilion at Morrill recently, and the price received for the animal being $11,000.

Herbicide Study Underway

A 3-YEAR herbicide monitoring program in cooperation with the Federal Water Pollution Control Administration is in progress by the Bureau of Reclamation.

Purpose of the program is to determine residue effects of herbicides used for weed control on irrigation systems.

Reclamation is participating in the study to obtain data in support of registration by the Department of Agriculture, of commonly used herbicides. Evidence must be submitted demonstrating that a herbicide can be used without injury to man, wildlife, livestock, or crops before that particular herbicide can be approved.

Some herbicides have now been in common use for as long as 20 years with very little documentation having been obtained as to their residues in water.

The Columbia Basin Project in the State of Washington was selected for the field phase of the study because of that project's broad system of canals, laterals, and drains of various sizes, lengths, and conditions.

Also available at this project are personnel experienced in water monitoring procedures and needs. The program is closely coordinated with the Quincy, East and South Columbia Basin Irrigation Districts, which actually carry out the weed control operations on the project.

Technical guidance is provided by Reclamation's Chief Engineer's Office in Denver, Colo.

The field segment of the program consists of a number of operations. Some of these include the planning of canal sampling and coordination with district employees making the herbicide application.

Steps Undertaken

Other steps include tracing the movement of water subjected to herbicide application through use of dyes, and collecting water samples periodically at a number of stations along the waterway. From 100 to 150 samples are collected from each canal and shipped to Denver for laboratory testing. The effort also calls for recording data on all parameters involved, and performing the initial steps in extracting the herbicide from the irrigation water.

Because 2,4-D is used extensively on irrigation systems of the Western States for controlling broad leaved weeds on ditchbanks, and it is not registered specifically for use on this type of area, top priority was given to this weed-killing agent in the first year of the study. Other agents will be monitored as the program develops.

After the sample extracts have been analyzed at Denver, automatic data processing is used to prepare the information for use in future reports and other purposes.

Five water channels on the Columbia Basin Project had been sampled, as of this writing. These were selected at random throughout the project.

The work is expected to show the extent of dilution of the herbicides as they move through the irrigation system, the degree of absorption in soils or plant life which takes place, and the amount of loss through evaporation.

The program is planned to continue through 1971. The different herbicides selected for study will be those for which a particular need is shown.

# # #

NEWS NOTES

"Keep America Beautiful" Council

The Bureau of Reclamation has been included in the Keep America Beautiful National Advisory Council, and will be represented by Reclamation Commissioner Ellis L. Armstrong, with Ottis Peterson, Assistant to the Commissioner, as alternate representative.

Ethiopian Project Starts

The technical press has reported the start of construction on the Finchaa River Project in Ethiopia, on which the Bureau made a reconnaissance investigation in 1963 for the Agency for International Development. The $49 million high-head hydro project is being initiated under a contract between the Ethiopian Electric Light and Power Authority and the Italian combine Impresit-Recchi.

New Edition of Sprinkler Irrigation Book

The Third Edition of the book entitled: *Sprinkler Irrigation*, is available. The Sprinkler Irrigation Association is publisher of the book, which includes a preface letter by Interior Assistant Secretary—Water and Power Development James R. Smith.

The new 444-page edition, printed in late 1969, presents new facts on irrigation methods and equipment, and new uses of sprinkler systems. A number of photographs, drawings and charts illustrate some topics.

Claude H. Pair, who wrote an article appearing in *Reclamation Era* for November 1969, is editor-in-chief of the new sprinkler book. Mr. Pair is research engineer (irrigation) with the U.S. Department of Agriculture at Kimberly, Idaho.

Contents listed are on water and soil conservation systems; soil-water-plant relations; water requirements; irrigation water supply; sprinkler pattern, spacing and selection; hydraulics of sprinkler systems; irrigation pumping plants; environmental control; fertilizer and chemical application; waste disposal; bibliography, appendix, and index.

Those who should find the book particularly useful include agriculturists, engineers, conservationists and college students.

It may be bought from the Sprinkler Irrigation Association, 1000 Vermont Avenue, NW., Suite 711, Washington, D.C. 20005.

Project Progress

The Salt River Project in Arizona has converted three vehicles to burn liquid propane instead of gasoline.

As part of a 90-day test, the SRP will evaluate operation of the vehicles in comparison with similar vehicles powered with gasoline.

The testing program is part of the SRP's overall environmental protection policy which was announced earlier. Conversion of the vehicles was in cooperation with a Phoenix propane distributor.

The Salt River Project is one of the first water projects developed by Reclamation.

John Rich, director of SRP operations services, said the three vehicles converted where a 2-ton truck, a zanjero truck, and a forklift. "These were chosen because they will receive the greatest and most varied use during the period. This will provide the most severe test of the converted equipment," said Rich.

The 2-ton truck is used by the project's irrigation maintenance crews almost continually each day. The zanjero pickup truck is operated nearly 24 hours each day, including a large amount of stop-and-go driving. The forklift also receives nearly constant operation under varied load conditions.

"These vehicles are especially valuable for testing because frequent periods of idling are followed by heavy load use," explained Rich. "This type of operation produces large quantities of pollutants when gasoline is used for fuel.

"We believe propane will produce only about one-sixth the quantity of hydrocarbons and about one-eighth as much carbon monoxide as gasoline," he added, "However, we need to test mileage and power of the vehicles following conversion."

Rich said the cost of operation is expected to be about the same as before, although some loss of power is anticipated.

"If the tests prove successful," added Rich, "we will give serious consideration to converting about 25 of our zanjero trucks for secondary testing."

The kit used for converting the smaller vehicles could be purchased at about $100 per unit. The kit needed for converting larger vehicles costs about $300.

Undersea Aqueduct Studied

The Bureau of Reclamation has completed a preliminary report on a potential closed aqueduct, submerged in the ocean off the Pacific coast to deliver needed future water supplies from northern to southern California.

The scheme would pick up flows from the Klamath River and other northern California rivers which now discharge large volumes of unused water into the ocean.

The prereconnaissance type report considers four major elements:

1. A preliminary evaluation of projected demands for water in southern California and potential supplies available from northern California.

2. An analysis of the state of knowledge regarding material for the pipeline and accessories, the environment of the undersea aqueduct, construction problems, and available information on tides, waves, currents, and other oceanographic factors.

3. Determination of what additional research and testing would be required to provide data for a full-scale reconnaissance investigation.

4. Development of a program for a full-scale reconnaissance investigation to determine the actual engineering and economic feasibility of the project.

Economics of the project are speculative until the complex engineering and other technical aspects of the aqueduct are more clearly understood and resolved. However, rough costs prepared by a consultant firm, the National Science Engineering Co., indicate that the cost of water delivered through the aqueduct could be competitive with the cost of water delivered by conventional means.

A full reconnaissance study to appraise the proposal would require 5½ years and about $2 million to complete. The aqueduct plan has been suggested as an alternative to the construction of conventional overland facilities or other methods of providing supplemental water supplies to southern California, including desalting.

The report recommends that if a reconnaissance study is undertaken, it be implemented in two phases. The first phase, taking about 2 years, would provide basic research data necessary to confirm the engineering feasibility of the aqueduct.

The project would involve work with relatively new materials, and a new environment as far as water transportation facilities are concerned. If results of the first phase study are favorable there would follow a 3½-year period of engineering study, designs, and cost estimates, economic analyses, and a study of alternative projects. # # #

Vietnam Vets Hunt on California Project

Vietnam amputees have been authorized by a recent bill passing the California State legislature to enjoy hunting pheasants from vehicles on Reclamation's Central Valley Project, and this was a successful day last November as seen at the back of the truck. The annual shoot will be conducted by groups and clubs. A good bird dog also accompanies the men. In this case two Job Corpsmen also were able to accompany the veterans.

The shooters are from left, Pete Parker (Corpsman) from Denver, Colo.; Lee Snow from Petaluma, Calif.; Huznerto Medrano from Texas; and Woodrow Kirton (Corpsman) from Waycross, Ga.

The wheelchairs are tied to keep them from rolling while the truck was moving.

New Film Available

A new 16 mm, documentary motion picture, "Water for the High Plains," has been added to the Bureau of Reclamation's film library. It tells the story of the Canadian River Project, with many of the sequences shot in the project cities. Also included is some outstanding footage depicting the recreational aspects of Lake Meredith. This lake also provides 103,000 acre-feet of water annually into a 322-mile long aqueduct system for 11 cities.

The 14-minute sound, full-color film is available to interested groups free of charge, from the Office of Chief Enigneer, Bureau of Reclamation, Building 67, Denver Federal Center, Denver, Colo. 80225.

For Colorado River Runners

The Bureau of Reclamation and the National Park Service are cooperating to provide advance information on projected flows of the Colorado River for the benefit of river runners in the Grand Canyon area.

Flows of the Colorado River in this area depend upon water releases through Reclamation's Glen Canyon powerplant, at Page, Ariz.

The notification procedure was developed with

a desire to keep the boatmen as fully informed as possible and to give them reliable forecasts of planned river operations.

About 6,000 visitors made the river run through the Grand Canyon area last year. River guides look for 8,000 to 10,000 to make the trip this year.

The Bureau of Reclamation will give advance information to the National Park Service, which will post it at both Lees Ferry and Phantom Ranch, Ariz., points where there is access to the river.

The information will include a 5-day forecast of daily minimum and average releases through the Glen Canyon powerplant in terms of cubic feet per second. The forecasts started March 15 and are made available each Monday and Thursday through October 15.

There will be revisions to the 5-day forecasts if changes would reduce the average release to below 8,000 c.f.s. or increase an average that is appreciably below 8,000 c.f.s. to above 8,000 c.f.s.

Should there be any anticipated radical deviations from the normal release pattern and quantity, especially any that would result in below-normal minimum releases or daily averages below 8,000 c.f.s., advance notice will be given as far in advance as possible, up to 2 weeks prior to the occurrence.

The advance information may be obtained during the river-running season by calling the Bureau of Reclamation's Regional Office in Salt Lake City. It also will be available at Glen Canyon powerplant and at the Power Operations Office at Montrose, Colo.

Water Hollow Tunnel Bored

The 80-ton mechanical mole used in drilling Water Hollow Tunnel of the Central Utah Project holed through last March 12 to end the drilling operation which began in late 1968.

The 4-mile-long tunnel is the first major step for the Bonneville Unit's Strawberry complex and will be the final link for the 37-mile-long Strawberry Aqueduct system which will eventually intercept the flow of eight streams into the enlarged Strawberry Reservoir, tripling its capacity. The huge mole, guided on its course through the mountain by a laser beam, cut a 13-foot diameter tunnel and holed through the rocky earth within 6 inches of the calculated breakthrough point.

Reservoir Renamed Bighorn Lake

The Board on Geographic Names has recently determined that the reservoir behind Yellowtail Dam is to be officially known as Bighorn Lake.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6730	Colorado River Basin Pilot, Atmospheric Water Resources Program, Colo.	Feb. 4	Installation and operation of an Opportunity Recognition and Cloud Seeding System for Operational Weather Modification Research in Colorado. (Negotiated contract).	EG & G, Inc., Environmental Services Operation Boulder, Colo.	$1,775,279
DC-6731-A	Southern Nevada Water, Nev.	Feb. 27	Construction of 25 miles of pipelines for Las Vegas Valley, Henderson, Whitney, North Las Vegas and Sahara laterals.	A & K Construction Co. and Associates Montebello, Calif.	12,324,316
DC-6740-A	Southern Nevada Water, Nev.	Feb. 26	Construction of 2.3 miles of Main aqueduct	TAB Construction, Inc. Las Vegas, Nev.	3,072,000
DC-6743	Central Valley, Calif.	Feb. 27	Construction of Folsom South canal, Reach 1, Sta. 2+98.38 to 69+16.	Syblon-Reid Co. Los Banos, Calif.	2,337,934
DS-6786	Missouri River Basin, Iowa.	Jan. 5	One 154-kv autotransformer and one 69-kv voltage regulating transformer for Denison substation, stage 05.	English Electric Corp. San Francisco, Calif.	217,214
DC-6788	Missouri River Basin, Wyo.	Feb. 6	Construction of 28 miles of Kortes-Alcova East 115-kv transmission line.	Industrial Electric Co. Casper, Wyo.	592,626
DC-6789	Boulder Canyon, Nev.	Mar. 12	Construction of two 5-million gallon concrete reservoirs and pumping plant for additional water supply at Boulder City, Housing Urban Development.	United Tectonic & Engineering Corp. Gardena, Calif.	1,194,139
DC-6790	Columbia Basin, Wash.	Feb. 26	Construction of Grand Coulee third powerplant and forebay dam.	Vinnell Corp., Dravo Corp., Lockheed Shipbuilding & Construction Co., and Mannix Construction, Inc. Alhambra, Calif.	112,525,612
DC-6793	Missouri River Basin, Minn.	Mar. 24	Construction of stage 10 additions to Granite Falls substation.	United Power, Contractors & Engineers, Inc. Seattle, Wash.	508,616
DS-6794	Kendrick, Wyo.	Mar. 2	Replacement turbine runners and turbine parts for Seminoe powerplant. (Negotiated contract.)	Baldwin-Lima-Hamilton Corp., Industrial Equipment Division Philadelphia, Pa.	432,765
DC-6796	Southern Nevada Water, Nev.	Mar. 6	Construction of pumping plants No. 3 and 6, forebay tanks No. 3 and 6, switchyards No. 3 and 6, and landscaping at pumping plants No. 3, 4, 5, 6, and 7 and Flamingo flow control station.	R. E. Ziebarth and S. B. Alper, and Ziebarth & Alper, Inc. Torrance, Calif.	1,687,400
DC-6798	Missouri River Basin, S. Dak.	Mar. 27	Construction of stage 02 additions to New Underwood substation.	Pearson Construction Co. Rapid City, S. Dak.	158,944
100C-1086	Columbia Basin, Wash.	Jan. 14	Construction of 18.4 miles of buried pipe drains for Blocks 11 and 49.	Oregon Construction Co., Inc., and George B. Paulus Salem, Oreg.	375,368
100C-1090	Yakima, Wash.	Jan. 14	Construction of 2.5 miles of concrete lining for rehabilitation of east lateral, Outlook Irrigation District.	Paul E. Hughes Construction Co., Inc. Tri Cities, Wash.	101,891
300C-299	Colorado River Front Work and Levee System, Ariz.	Feb. 16	Construction of pipeline and canal for Mittry lake	Arrow Construction Co. of Arizona, Inc. Yuma, Ariz.	118,367
DC-6749	Missouri River Basin, N. Dak.	Mar. 31	Construction of 15.4 miles of unlined McClusky canal, Reach 3A.	William Clairmont, Inc. Bismarck, N. Dak.	7,991,331

RECENT BID REQUESTS*

Project	Description of work or material
Central Utah, Utah.	Earthwork, culverts, and surfacing for 9.7 miles of Currant Creek road improvement and Forest Service road relocation. About 45 miles southeast of Heber.
Central Valley, Calif.	Furnishing materials and constructing a superstructure for the Auburn-Foresthill Bridge, which is to be a steel truss of cantilever type with a suspended center span. The bridge truss is to be 2,140 ft long with three spans: 639, 862, and 639 ft. Height above the river will be about 700 ft. The concrete roadway will consist of two 22-ft lanes, with a 5-ft-wide sidewalk on the outside of each lane. About 2 miles northeast of Auburn.
Do	Earthwork, concrete lining, and structures for about 25.7 miles of concrete-lined drain with an 8-ft bottom width and a lining height of 9.6 ft; constructing 14 miles of dikes in the 1,300-acre reservoir with top widths of 10 ft and 14 ft and an average height of 6 ft; and constructing three prestressed concrete O&M bridges. San Luis (Station 4161+00 to Station 5518+40) and Kesterson Reservoir, First Stage. From about 5 miles east of Gustine to about 1 mile west of South Dos Palos.
Do	Earthwork and 4-in.-thick concrete lining for 14.5 miles of Folsom South Canal with a capacity of 3,500 cfs, a bottom width of 34 ft, a depth of 20 ft, and side slopes of 1½:1; constructing nine reinforced concrete bridges consisting of one railroad, two state highways, and six county road bridges; five reinforced concrete overchutes, three pipe overchutes and three culvert crossings; two 24-ft-diameter monolithic concrete pipe siphons, one 1,300 ft long and the other 895 ft long, and a double 16- by 16-ft reinforced concrete siphon 270 ft long. Near Folsom.
Do	Earthwork, structures, and surfacing for the following access roads: 1.5 miles on the right abutment; 2.3 miles to the powerplant site; 3 miles on the left abutment; and 0.5 mile of connecting road. Auburn damsite, near Auburn.
Colorado River Storage, Wyo.	Additions to the Archer Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing two 230-kv power circuit breakers, and associated electrical equipment. About 10 miles east of Cheyenne.
Colorado River Storage, Colo.	Additions to the Blue Mesa Switchyard will consist of constructing concrete foundations; furnishing and erecting steel structures; transporting and installing one oil circuit breaker, and associated electrical equipment; and furnishing and installing additional electrical equipment. About 28 miles west of Gunnison.
Columbia Basin, Wash.	Constructing about 18 miles of buried pipe drains, Block 87, east of Royal City.
Do	Constructing about 17.5 miles of buried pipe drains, Block 87, east of Royal City.
Do	Furnishing, installing, and testing two vertical-shaft, 3-phase, 60-hertz, hydraulic-operated motor-generators having a synchronous motor rating of 67,000 hp at 200 rpm, 13,200 volts, 100 percent power factor, and a generator rating of 50,000 kva at 200 rpm, 13,800 volts, 100 percent power factor. Grand Coulee Pumping Plant, Units P/G7 and P/G8.
Do	Nine 500-kv power circuit breakers for Grand Coulee 500-kv Switchyard.
Do	Three generator voltage isolated-phase bus structures rated 15-kv, 31,000-amp, including cooling equipment, grounding switches, and generator surge protective equipment for the Grand Coulee Third Powerplant.
Do	One 3-phase, 105/140/175-mva, 230- to 13.8-kv, OA/FA/FOA power transformer for Grand Coulee Pumping Plant.
Do	Three 4,600,000-ft-lb oil pressure, electrohydraulic, cabinet-actuator-type governors for regulating the speed of three 820,000-hp, 72-rpm hydraulic turbines for Grand Coulee Third Powerplant.

See footnote at end of table.

RECENT BID REQUEST*—Continued

Project	Description of work or material
olumbia Basin, Wash.—Cont.	Two 250,000-ft-lb oil pressure, electrohydraulic, cabinet-actuator-type governors for regulating the speed of two 67,500-hp, 200-rpm pump-turbines for Grand Coulee Pumping Plant.
Do	Furnishing and installing one 1,900-ton gantry crane. Estimated weight: 2,000,000 lb. Grand Coulee Third Powerplant.
Do	One 21-ton, low-pressure, CO_2 fire protection system with piping, valves, anf accessories to protect three 600-mw generators for Grand Coulee Third Powerplant.
ryingpan-rkansas, Colo.	The completed Pueblo Dam will be a zoned earthfill embankment about 8,450 ft long and 165 ft high with a concrete buttress overflow spillway section 1,750 ft long and 175 ft high. Work on this contract will include: diversion and care of river; excavation for spillway and spilling basin, for earth dam embankment foundation and for borrow excavation for cutoff trench refill; placement of concrete in dam foundation; placement of earth embankment as cutoff trench refill; construction of Bessemer Ditch outlet works consisting of an intake structure, a 7-ft pressure conduit, a gate chamber, a 9-ft 6-in- wide, horseshoe, freeflow conduit, stilling basin canal, and Parshall flume. Work will also include reservoir clearing. On the Arkansas River, about 8 miles west of Pueblo.
Do	Constructing Cunningham Tunnel, about 2.9 miles long; Ivanhoe Crossing, about 450 ft long, and Nast Diversion. Alternate schedules for tunneling will allow construction of either a horseshoeshaped section with an unlined "A" line dimater of 8 ft 9 in., or a circular section with "A" line diameter of 8 ft 7 in. The tunnel will be nominally unlined with shotcrete specified for support. Steel rib supports and formed concrete lining will be specified for certain reaches. The tunnel will be driven from the outlet portal. Access to the outlet portal will be over the Nast Tunnel access road that will be constructed under Specifications No. DC-6803. The Ivanhoe Crossing will extend from the Cunningham Tunnel outlet portal to the inlet portal of Nast Tunnel, and will be a 7-ft 3-in. by 7-ft rectangular concrete conduit constructed on a tunnel muck fill embankment. A reinforced concrete access structure will be required at the outlet portal of Cinningham Tunnel. Nasr Diversion will consist of Nast Diversion Dam on Ivanhoe Creek and about 300 ft of rectangular concrete conduit connection to the Ivanhoe Crossing. Tunnel outlet portal on Ivanhoe Creek, a tributary of tht Fryingpan River, about 34 miles east of Basalt.
Do	Constructing Hunter Tunnel (first reach) about 4.4 miles long. Alternate schedules for tunneling will allow either a horsehshoe-shaped or cicular section, with an unlined "A" line diameter of 8 ft 6 in. The tunnel will be nominally unlined with shotcrete, specified for support. Steel rib supports will be specified for certain reaches. No formed concrete lining will be required in this contract. The tunnel will be driven from the outlet portal and will terminate underground near Hunter Creek. A 55-ft-tall vertical access shaft will be driven to the surface from the tunnel at Hunter Creek. The 30-cfs Sawyer Diversion will consist of a diversion structure, a 3,000-ft-long pipeline, and a Parshall flume. Tunnel outlet portal on Chapman Gulch, about 32 miles east of Basalt.
Do	Constructing Nast Tunnel, about 3 miles long; Granite Adit, about 0.13 mile long; and the Fryingpan Conduit, about 2,350 ft long. Alternate schedules for tunneling will allow construction of either a horseshoe-shaped section with an unlined "A" line diameter of 9 ft 9 in., or a circular section with "A" line diamteter of 9 ft 4 in. The tunnel will be nominally unlined with shotcrete specified for support. Steel rib supports and formed concrete lining will be specified for certain reaches. The tunnel will be driven from the outlet portal. The Fryinpan Conduit will extend from Nast Tunnel outlet portal to the inlet portal of Charles H. Boustead Tunnel and will be an 84-in.-diameter concrete pipe with 60-ft maximum head. A reinforced concrete access structure will be required at the outlet portal of Nast Tunnel. Lily Pad Diversion will consist of a 20-cfs inlet structure above the tunnel and a 220-ft vertical shaft connecting to Nash Tunnel. Tunnel outlet portal on the Fryingpan River, about 35 miles east of Basalt.
Do	Earthwork and structu4es for 8.7 miles of 18-ft-wide unsurfaced tunnel access roads. Cunningham and Morman Tunnels access roads, about 30 miles east of of Basalt.
Do	Clearing, earthwork, culverts, and surfacing for about 7.7 miles of relocated county road. County Road 9 and 9A, at Turquoise Lake, about 5 miles west of Leadville.
Do	Excavating and replacing 1,800 cu yd of subgrade and base course; placing liquid asphalt prime coat and 2-in. plant-mix bituminous surfacing on 5.9 miles of county road, on 3,500 sq yd of parking area, and on 1,217 lin ft of road ditches; constructing an 18-in. corrugated-metal pipe culvert and 1,100 lin ft of 8-in. perforated metal pipe drain; constructing 730 lin ft of 4-ft chain link fence; installing seventy-three 6-ft precast concrete curbs; and removing and stock-piling 119 wood guide posts and 50 lin ft of guardrail. County Road 104, about 20 miles east of Basalt.
Do	Furnishing and erecting a standard prefabricated metal building, 32 by 94 ft, with laboratory and offices; installing air conditioning, lighting, and plumbing; constructing bituminous-surfaced roadways and gravel-surfaced parking and storage areas; and erecting a 6-ft-high chain link fence. Puebleo Damsite, near Pueblo.
MRBP, Kans	Constructing about 4 miles of buried pipe drain varying in size from 6 to 12 in. and grading and shaping about 0.9 mile of existing open drain. Bostwick 20-3-5 drain, near Courtland.
MRBP, Minn	Additions to Morris Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing one 230-kv and one 115-kv power circuit breakers, and associated electr cal equipment. About 4 miles west of Morris.
MRBP, Mont	Additions to the Yellowtail Switchyard will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing three 230-kv and one 115-kv circuit breakers, and associated electrical equipment; and grading and fencing an extension to the area. About 45 miles southwest of Hardin.
MRBP, N. Dak	Excavation work, for 2.2 miles of canal with a 25-ft bottom width and a capacity of 1,950 cfs. The cuts will vary from 36 ft to about 100 ft in depth. McClusky Canal, Reach 3C, about 2.5 miles west of McClusky.
Do	Constructing 2.2 miles of 6- to 18-in.-diameter pipe drain and manholes. Pilot Drain, Block 1, Oakes, Station 192 to Station 291+61.
Do	Additions to the Watford City Susbtation will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing two 115-kv circuit breakers, and associated electrical equipment; regrading and resurfacing the existing yard; and grading and fencing an extension to the area. On U.S. Highway No. 85, about 1.5 miles south of Watford City.
MRBP, S. Dak	Additions to the Groton Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing one 115-kv circuit breaker, and associated electrical equipment. About 5 miles south of Groton.
Pecos River Basin Water Salvage, Tex.	Clearing along the Pecos River from Orla to Pecos.
Teton Basin, Idaho.	Constructing a 2-mile-long, 28-ft-wide gravel-surfaced access road. Two to 4 miles northeast of Newdale.

*Subject to change.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

Natural Resources of . . .

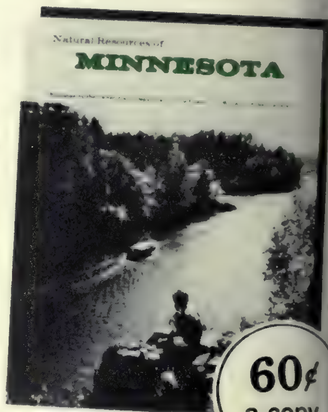
MINNESOTA

WATER • FORESTS • WILDLIFE • HISTORY • RECREATION • MINERALS

Whether your interests in this beautiful State are for travel, recreation, or general information, this booklet fits your needs. Generously illustrated and descriptively written, this publication takes the reader on a Statewide tour of scenic beauty, industrial development, varied natural resources, and recreational opportunities.

National and State parks are explored and historic sites are visited. Angler and hunter will learn of the fish and wildlife to be caught. For the student, this is a colorful introduction to the State's history, present development, and future progress. Published by the Department of the Interior, the booklet includes a summary of Federal programs devoted to natural resources.

Other Booklets In This Series Now Available: **MARYLAND • NORTH DAKOTA MASSACHUSETTS • TEXAS • UTAH • IDAHO • WASHINGTON • SOUTH DAKOTA OHIO • ALASKA • OREGON • COLORADO • CALIFORNIA • ARIZONA • WYOMING WEST VIRGINIA • NEW MEXICO • NEVADA • MONTANA • INDIANA • PENNSYLVANIA**



60¢ a copy

Convenient order form with individual prices is provided on reverse side.

Street address
Name

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS
RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OF

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

Enclosed find $............. (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

...... MINNESOTA. I 1.91:M 66	60¢	...... MARYLAND. I 1.91:M 36	
...... ALASKA. I 1.91:Al 15	65¢	...... WEST VIRGINIA. I 1.91:W 52 V	
...... TEXAS. I 1.91:T 31	45¢	...... OHIO. I 1.91:Oh 3	
...... ARIZONA. I 1.91:Ar 41	45¢	...... WASHINGTON. I 1.91:W 27	
...... MASSACHUSETTS. I 1.91:M 38	45¢	...... NEW MEXICO. I 1.91:N 42 M	
...... COLORADO. I 1.91:C 71	50¢	...... IDAHO. I 1.91:Id 1	
...... OREGON. I 1.91:Or 3	50¢	...... UTAH. I 1.91:Ut 1	
...... NEVADA. I 1.91:N 41	45¢	...... WYOMING. I 1.91:W 99	
...... CALIFORNIA. I 1.91:C 12	60¢	...... SOUTH DAKOTA. I 1.91:So 8 D	
...... MONTANA. I 1.91:M 76	50¢	...... INDIANA. I 1.91:In 2	
...... PENNSYLVANIA. I 1.91:P 38	65¢	...... NORTH DAKOTA. I 1.91:N 81 D	

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DOCS.

August 197

RECLAMATION era

A WATER REVIEW QUARTERLY

Aug. 1970 • Vol. 56, No. 3

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER. Inspiring view of famous Rainbow Bridge, Utah.

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAG

What Can I Do?

The desire to improve the environment, which voiced enthusiastically by the great segment of thoughtf Americans, was spearheaded by President Nixon's e vironmental message to Congress last February.

"The task of cleaning up our environment cal for a total mobilization by all of us," said the Presiden "We shall be reaching out in an effort to enlist millio of helping hands . . . willing spirits . . . volunteer citize who will put to themselves the simple question: Wh can I do?"

Because the great movement is vital to the Natio and the world, environmental problems are being attacke by the Bureau of Reclamation with all-out concern. W feel the scope of the movement should combine all ge physical and manmade surroundings both for the prese and the future. It should not be purely protective or pr ventive; for Man is here to stay unless he dies by his ow alienation from or ruination of the biosphere. We must u the resources Nature has provided, but we must use them a wise manner.

The Bureau of Reclamation has had nearly thre quarters of a century of resources management and e vironmental protection and enhancement experience. I dams, which control disastrous floods during one seaso utilize the same stored waters to avert drought in wate short areas during other seasons. Our manmade lakes pr vide some of the Nation's most beautiful and popul recreational environment, as well as enhancement of fi and wildlife resources.

Municipal water supplies provide full or pa service to 15 million people. Irrigation waters mea multiple food crops, many of them wholesome specialt foods which people all over the Nation are happy to hav regularly on their dinner tables. Pollutionless electr power generation results in better and more comfortab home life, both in cities and rural areas.

Reclamation is constantly reviewing its progra with imaginative new environmental benefits in mind. I is moving ahead with further mobilization of leadershi to help in any other way possible with the urgent effo for rescuing and bettering Man's existence.

ELLIS L. ARMSTRONG
Commissioner of Reclamatio

Secretary Hickel meeting with youths in his office last spring.

pening doors to new environmental spirit

YOUTH INSIGHT VITAL TO ENVIRONMENTAL REFORM

by WALTER J. HICKEL, Secretary of the Interior

THIS has been an age in which all obstacles were taken as challenges.

Halted by rivers, we built bridges and tunnels. itying the hungry, we developed a powerful agri-ltural industry. Vast cities came into being to use our evergrowing millions of people.

But the achievements were one-sided. In meeting ese challenges, we tore minerals from the earth, nuded forests, wasted soil, fouled rivers, and led the air with stench. We were almost undone our victories.

Today, however, man is finally learning that e earth will not tolerate a "master race." Nature is rebelled against our intolerance and pursuit just our needs without regard for their effect Nature.

We are starting to change this dream of power and to make amends—to contribute to a life in harmony with our natural environment.

President Nixon has asked us, urgently, to work with him in repairing the damage to our eco-system and in seeking a new quality of life. We, in the Department of the Interior, dedicate ourselves to renew and conserve our natural heritage. We strongly encourage the younger generation to join us in this endeavor.

We need our cities; we need our tunnels and bridges. We need our farms, our industries and our highways. But the task before us in the 1970's is to harmonize these needs with Nature's. To me, this challenge is an exciting and demanding frontier, and one which could provide a "new commission" for America's creative youth.

Way provided for youths to realize personal involvement.

Formed a Task Force

Last March I formed a Task Force on Environmental Education and Youth Activities to coordinate three major educational and action programs involving responsive young people. The programs are: 1. the National Earth-Day Teach-In, 2. the National Environmental Study Areas, (NESA), and 3. the Student Council on Pollution and the Environment, (SCOPE).

In the case of the Earth Day Teach-In, the task force provided about 1,200 speakers in response to invitations for that landmark event held last April 22. The total audience in mostly colleges and public schools was at least 300,000. The task force is continuing the significant objectives of the nationwide teach-in and providing information and speakers to colleges, high schools and other groups.

The task force is helping to expand NESA, the National Environmental Study Area program. In this endeavor, areas deemed particularly suited to frequent visits by classes wishing to see ecology at work, are being made available. Goal of the NESA program is to create an environmental awareness that will lead the individual youth or adult to a personal sense of involvement, and eventually to shaping an environmental ethic as a guide.

NESA areas, already established by the National Park Service, have been in successful operation. Many more such areas are being added and sponsored by other cooperating agencies.

New Dimension

This part of the NESA program results in a valuable new dimension of public use of public lands and facilities which are supervised by Government agencies.

The Bureau of Reclamation is one of the Interior agencies planning NESA areas to help groups study the environment. This 68-year-old agency builds a number of water projects which are vital to man's existence in the 17 Western States.

Reclamation's multipurpose water facilities are fundamental examples of how man is using his resources. These projects provide water supplies for people's homes and industries, for farmers to grow the best crops during the best seasons, for enhancement of fish and wildlife, and for fishing and recreational purposes.

Other uses of the facilities are for flood control, water-quality improvement, river regulation and control, and the pollution-free generation of hydroelectric power.

Reclamation also administers atmospheric water resources research programs designed to develop techniques of increasing water supply to arid and semiarid areas. The Bureau of Reclamation also is monitoring the ecological effects of such atmospheric programs to determine their environmental compatibility.

Another important phase of the NESA program is that it makes environmental curricula available for possible enrichment use in all public school grades.

The third task force action program in Interior is SCOPE, the Student Councils on Pollution and the Environment. The SCOPE effort already is assisting us greatly as an early warning system spotting major pollution, and notifying the proper authorities when major projects are launched without regard to the environment.

Established on college and university campuses throughout the country, SCOPE is a student-managed organization which grew out of seminars held last December in nine U.S. regions by Interior's Federal Water Quality Administration.

Outdoor study areas help students get environmental awareness.

ays to Listen

Through SCOPE we are showing government 1at it pays to listen—as well as talk. It was organized to establish a means of direct access by udents to Federal officials and Government departments concerned with the environment so we in put their ideas into the decisionmaking rocess.

At the same time, we can provide these students ith our informational research, and technical icilities for their use in developing new programs.

We are exploring the possibilities of expanding COPE into an interdepartmental organization so 1at it can have impact on all Federal agencies orking on water-, air- and land-pollution roblems.

To accomplish such tasks, I look to our young eople and their creative talents. They possess 1inds and spirits free enough to view the world ithout preconceptions. And because they are rimming with new values and approaches, they 1ust be heard. For it is they who will have to live ith the solutions—good or bad—to our Nation's roblems long after my generation has gone.

President Nixon touched on an extremely vital point recently when he said:

"The younger generation in America is enormously interested—not simply in the pursuit of a good living—but also in those causes that are beyond self."

When he made that statement, the President was referring to the deeper values which many of today's youth are seeking. And the President made it clear that he believes the young people of America can make a contribution. I was reassured of this when he continued, "I want them in the high counsels of the Government of this country."

The question is, how can one best make sure his ideas and beliefs will be considered in development of national policy?

In Regions

Regional headquarters for SCOPE are in Boston, Mass.; Charlottesville, Va.; Cincinnati, Ohio; Chicago, Ill.; Kansas City, Kans.; Atlanta, Ga.; Dallas, Tex.; San Francisco, Calif.; and Portland, Oreg.

A positive approach to meeting needs—while

improving the environment—would prove that we do not suffer from too much technology, or too many specialists. But instead, we suffer from too much short-term technology which is attuned only to the service of man's more immediate needs.

In a new spirit of concern for the planet we have used so badly, the coming generation can be in the vanguard of a new breed. The task is nothing less than the creation of a whole new civilized industrial technology, to replace the brute machine that has been so destructive of ecology.

Creating that technology is a challenge that demands the best our Nation can produce. We must "rethink" every machine, every tool, every technique in the light of the needs of the ecology of the earth.

At the same time we must find fresh ways to meet the staggering material demands of the human race in the foreseeable future.

If you have an idea which you believe has merit, how do you make it heard? If you have dissent, how do you do it? If you are in government, how do you respond to opposition?

The effectiveness of a democratic society depends upon its ability to accommodate dissent; to provide an orderly process by which disagreements can be worked out and wrongs righted; and the structure of the system modified in the face of changing conditions.

Today there are some who maintain that government and its institutions are so vast they can no longer respond to the needs of the people. Increasing numbers of Americans have taken to the streets to express their views on basic issues. More and more, a few young Americans claim that civil disobedience is a necessary instrument for effecting needed social change. For such persons the difficult problem is to maintain perspective.

Make Channels Adequate

It is hard for these persons to see that the challenge in front of us is to make the channels built into our Government system adequate to the task for national renewal.

In the final analysis disobedience and hostility tend plainly to impair operation. This is not new. When man first appeared on this planet about 2 million years ago, he was nearly helpless in a hostile environment. Self-protection was the primary need.

This drive has remained man's overriding concern. Self-defense has escalated from the protective wooden club to the massive machinery which now stands poised and ready to destroy all life o earth.

The price for man to protect himself is high, an even risky. Clearly, some rearranging of the N tion's priorities is in order. As we make the shi from security to opportunity, our attitude towa dealing with the environmental crisis will chang

If we approach the task reluctantly, it will n be done well. We must answer the challenges they come, and do a job of which future gener tions can be proud.

For example, it is time we decided what is t highest and best use of a forest. Is it to be clear for yet more homes and factories? . . . Or wou a higher use be as a park?

We also must inventory and catalogue all o water supplies, our public lands, our Continent Shelf, and our beaches.

Our Values

And our values must not be only in moneta terms. New criteria are needed which can put a appropriate value on ecology, natural beauty an recreation.

It also would be a serious mistake to leave t responsibility of caring for our environment e tirely in the hands of government. Fortunatel this is not the prevailing attitude in the countr Thousands of individuals and scores of industri are beginning to take spontaneous initiative.

I urge our youthful specialists to "link up" i good environmental thinking. Use your talents t tackle the really tough problems of our time Never be afraid to stand up and say what yo think.

Your views may be unpopular. They may mak some people uncomfortable. But believe me, yo have friends—in government, in industry, in t educational establishment.

Don't allow yourselves to be polarized on th issues. Most of them today are not simply "yes o no" . . . "night or day" questions. Winning peopl over is a much more mature, and in the long ru a far more effective way to change society tha alienating people.

Bringing people together in the name of a vit cause which affects all mankind is the highest sc ence of our times.

And to solve the great environmental difficulti will require high science which—I am confident will be mastered by our talented and thoughtf youth who sincerely dedicate themselves to shapin and building for the future. # # #

xcitement for
ird watchers

Golden Eagles Nest in Man-Made Tree

GOLDEN eagles don't usually nest in trees—least of all steel trees created by man. But rather friendly pair of this rare bird not nly abandoned their natural environment to move nto a pad of twigs in a steel tree, but they hatched t least one youngster in this man-made habitat.

Such an eagle nest in a tall electric tower near)'Neill Forebay Lake, Calif., is not included in he area's master plan for wildlife enhancement. Iowever, considerable developments for the enancement and protection of birds and wildlife are ocated in that part of California. The developnents were included in the multipurpose Central Valley water project by the Bureau of Reclamaion and the State of California.

Golden eagles usually nest in cliffs in remote laces, and usually lay two eggs.

According to reports from Reclamation Region headquarters in California, many naturalists vatched the elder golden eagles with binoculars or weeks last spring, and it is known that hatchng finally took place. But it was not learned vhether one or two eaglets were the object of the arents attention.

California State Fish and Game specialists beieve that one of these parent eagles is the one vhose wing was repaired by a representative of hat organization in November 1969 after the bird vas injured by flying into a high tension powerline n the area.

or Falconry

Having a wing spread of 7 feet or more, the golden eagle is the largest of the birds of prey used or falconry. However, owing to its extreme feocity when deprived of its prey, and because it cannot make quick turns in flight, it is seldom trained for that sport.

A park ranger in the reservoir area says the nest was made last year by a crow and last February taken over by red-tail hawks. Shortly thereafter, the eagles moved in. The eagles changed sitting duties on the nest every five hours and 20 minutes. The mate showed up seemingly from nowhere, apparently diving down from a great height.

Observers from as far away as Los Angeles were drawn to the site because of the accessibility by car. At times as many as a dozen naturalists were seen watching goings on at the stick sanctum nestled near the top of the 141-foot tower.

Watchers said that after the crows left the home they built in the tower, each new tenant, including the eagles, added a few furnishings to their liking. The eagles couldn't care less about the underside of their nest, but a neighborly sparrow found a place there in which it fixed a nest. # # #

The golden eagle, left, is circling its tower home.

WATER Quiz

1 This field of yellow-topped seed plants
← irrigated on a Reclamation project i
Oregon. What kind of vegetable seed is it
(a) peas
(b) turnips
(c) carrots

2 Reclamation's leading visitor attractions ar
Lake Mead behind Hoover Dam, a ke
feature of the Lake Mead National Recre
ation Area in Nevada and Arizona; an
Jackson Lake Dam and Reservoir in Teto
National Park in Wyoming, which had
combined 10.5 million visitor-days last yea
Would you suppose visitors to the two area
would be equal?

3 What is the recently popularized—"stud
of biology dealing with the mutual relation
tween organisms and their environment?
(a) ethnology
(b) etymology
(c) ecology

4 Which Western State is celebrating its 125t
Anniversary this year?

5 Pleasant picnicking and boating is shown i
← this photograph on a Reclamation projec
area in California. Would you say these tw
activities rate as highest in recreatio
participation?

ANSWERS:

(1.—(b) turnips; 2.—No. Lake Mead had most
ith 6.9 million, and the Jackson area had 3.4
illion; 3.—(c) ecology; 4.—Texas; 5.—No, they
re fourth and fifth respectively; higher are sight
eeing, fishing, and camping.)

ike peeling
ı big orange

SHEARING SQUIRMY SHEEP

SHEEP shearing last March brought Reclamation photographer L. W. Nielsen out to he low-rolling hills of California's Central Valley.

Few areas of the Nation have as much agricul-ural variety, or as much potential, as the Central Valley. Production is high, not because the rain-all is adequate—which it is not—but because the oil is rich and key water suppplies are being provided jointly by the huge multipurpose water levelopments of the Bureau of Reclamation and he State of California.

One of the valley's agricultural endeavors of onsiderable importance is the sheep industry. On he appointed day, in the Los Banos area, sheep nen herd flocks of the wooly animals from many niles to a headquarters with rambling low-fence orrals. The sheep run and frolic with one another n the crisp spring air, but they are carrying an xtra 8 to 10 pounds of wool which shakes like ello, and soon will be parted from their loose kins.

A section of the corral narrows into a single-file unway. Herders gradually guide the flock into his narrow passage and calm them. The wait here s like people lined up for arm innoculations by nurses. The difference is that instead of needle xperts, the sheep are greeted by a line of clipper xperts in a shoplike tent.

Another difference is detected by one's nose. The photographer thinks sheep have a barnyard odor ll their own, possibly a little less perfumy than a nurses dispensary, and much less than a barbershop.

Similar to Barber Shop

The special clippers, or sheep shears, are powered by a portable electric source, similar to

Like a line up for innoculations.

barbershop clippers. The shear operators move the sheep around on the floor—upside down and sideways—with one hand, while with the shear-hand they rapidly relieve the sheep of their fleecy outer layer of weight, like peeling a big squirmy orange.

The work is strenuous for the shearers. They work constantly in a bent position. As shown in the photograph, much of the weight of a shearer's upper body can be relieved by use of a strong belt on a rope which is hooked on the framework above.

Next to the skin, the sheep's wool is a virgin creamy yellow color because it has been protected from dirt. However, the wool furtherest from the skin has the color, and the presence, of dirt.

In addition to the dirt, sheared wool still is permeated with the sheep's natural skin oil. This helps the wool hang together sufficiently for a man to gather the fleece easily in his arms and carry it out of the tent to huge burlap bags.

The looks of a sheared sheep reveals a big change. It isn't roly poly anymore, and it probably feels a bit chilly. However, in its own uncon cerned way, it wastes no time in starting anoth miraculous growth of wonderful wool.

Comfortable Wool

Knowing this growth is going on again, ma counts his blessings—he highly values the comfo of wool sweaters and other such products, and fully appreciative that the production by the little animals far outdoes any of his own creati textiles.

Meanwhile, each large bag is filled with abo 300 pounds of wool—the harvest of about sheep—and the bags must be packed tightly an sewn across the top. The bags are then ready for long ride: First, to town on a truck, then by rail the opposite side of the country, Massachusett where many other wool processes take place.

This is one of the many ways in which dista parts of the Nation benefit by results of Reclama tion water project activities in the West.—GJF

Top left: Similar to peeling a big lively orange.

Top right: Large bags are packed tightly.

Bottom right: Bags of wool ready for a long ride.

Below: They're not roly-poly any more.

388-471 O - 70 - 2

Tells of success with solid set irrigation sprinklers

HOW MY NON-JOYS ENDED

by DENNIS DAVIN, Washington

I recently had the pleasure of seeing Mr. Al Gray's slide-talk on the history of sprinkler irrigation. I was surprised how far back in time, into the 1920's and 1930's, extensive sprinkler irrigation was practiced.

My earliest recollection of sprinkler irrigation was in the early 1940's on our farm in Walla Walla, Wash., where I witnessed one of the first installations of buried mainline in that area. The trench was hand dug, the pipe was thin-wall steel of the kind available during those war years and it was enameled with coal tar inside and out.

That pipeline of about 3,000 feet is still in use. The laterals were 20-foot sections of 2-inch galvanized pipe with a snap-latch coupler. These were soon replaced with 3-inch aluminum pipe and a revolutionary quick coupler.

About this time I was getting big enough to be introduced to the "joys" of twice-a-day pipe moving and over the next half dozen years I spent many hours trudging through ankle-deep mud in sugar beets or knee-high alfalfa, carrying a 40-foot length of sprinkler pipe.

Certainly the man was right who said that the best way to drive the youngster off the farm is to have him move sprinkler pipe for a few years. I used to think, as I plodded along, pipe in hand, how nice it would be to have sprinkler pipe coming off of every valve so that there would be no need of moving the pipe, just of changing the valves. I dismissed this as the youthful fantasy of a wandering mind.

Indeed when I look back on it, it is still perhaps impractical to put solid- set on alfalfa and pasture in heavy silt loam soils such as those around Walla Walla, but under other conditions it may be impractical or even foolhardy not to use a solid-set sprinkler system. Such is the case with our farm at Richland.

Driven From Farm

I must say that I was driven from the farm by twice-a-day sprinkler moving, and after college, I drifted into the real estate development business. In the early 1960's, I started accumulating land near Richland, not with the intent of farming, but with the idea of merely holding the land as a speculation.

Being accustomed to heavy silt loam soils, I considered the land not arable. In 1967, the local canal company offered to sell me water at quite a reasonable price. The city of Richland then offered a very favorable power rate on the basis of "interruptible power". These factors prompted my further investigation of the possibilities of irrigating my "sand pile". Farming this ground presented several unusual conditions and problems which are:

1. *Very light soils.* Of the 950 acres presently under irrigation, less than 200 acres were classed as irrigable (gravity flow type) by Bureau of Reclamation tests of several years ago. The balance graded from coarse, excessively drained loamy sands to "sugar sand" with little or no organic matter. The waterholding capacity of most of the soil is less than 1 inch per foot.

2. *Irregularly shaped fields.* The property is cut with three roads, one trunk powerline, one phone line and one railroad. This in itself would be easy enough to live with except that all these lines and roads run in different directions. This factor made side rolls uneconomical, and center-pivot moves impossible.

3. *Scarcity of dependable labor.* This is a problem which pervades all irrigated farming areas but is especially acute in the Tri-Cities area where there is heavy competition for the existing unskilled labor supply from the construction trade.

Solid-set sprinkler systems are shown in all the photographs. They are courtesy of the Sprinkler Irrigation Association.

4. *High seasonal winds.* This, combined with blow sands makes farming a very hazardous undertaking using standard types of sprinkler equipment.

These four factors were basically influential in my determination that a solid-set or permanent-set system was the logical, perhaps the only choice we had. As we studied different system designs, and costed out the various possibilities, it became apparent that our incremental costs for solid-set were about $160 per acre above the cost of side rolls. Understand that this was an unusual case, where because of the irregular shape of the fields, the cost of side rolls was higher than normal.

Only Alfalfa

It was also quite apparent that about the only crop we could successfully hope to raise under side rolls would be alfalfa. Because of the winds and the light soils it would be quite impossible to grow row crops. However, using solid-set, we felt we could grow any field or row crop we wanted.

As I intended to rent out the ground, I compared relative expected rents. With side rolls in alfalfa I could expect about $40 per acre per year in rent. With solid-set I could expect about $100 average rent per acre.

Therefore, an added investmentof $160 per acre would pay back $60 per year in added rent. This means about a 3-year payout of this added investment at 10 percent interest.

It is, of course, also necessary to consider the average net return on total investment in order to determine the overall feasibility of the project. In this case it was apparent that I could develop this property with solid-set cheaper than I could buy land which would return a similar amount of net rent. This, of course, does not consider the opportunity cost imputed in raw-land cost caused by the adventitious increment in value from the day I bought it until the day we started developing it. I considered this opportunity cost to be offset by the discounted future value enhancement obtained by irrigating or "greening up" the land.

In short, it was feasible to irrigate the land and our highest cost-return ratio was obtained by a solid-set installation. I wanted a solid-set, however, that would meet a further requirement as far as operation was concerned. It should be semiautomatic and semipermanent.

Today, my farm consists of 520 acres of semiautomatic, semipermanent solid-set, about 260 acres of conventional solid-set and the 170 acres of "heavy" ground in handlines. It is my experience

with the semiautomatic, semipermanent solid-set that is of most interest.

My System

I would like to quickly describe as best I can the design of my solid-set system. The system is semipermanent in that the aluminum pipe is laid above the ground in what I call a dead row. All farming operations are carried on around this pipe which remains in place permanently. In effect, we "strip farm" in the 50 feet between pipes.

I have described this system as semipermanent and do so because there is one operation, digging potatoes, that has necessitated the removal of some of the pipe. I feel that someday in the not-so-distant future, advancements will be made in potato-harvesting equipment that will allow us to leave the pipe in place even during this operation.

All other operations in growing potatoes, and all operation in growing our rotation crops such as alfalfa are done leaving the pipes in place.

We have experimented with various methods of keeping this dead row free of weeds. Several possibilities exist although I think twice-a-year spraying of the piperow with 2–4–D is the best answer in our situation. It would also be possible to plant a short growing grass strip along the pipeline. Sterilizing the soil with atrazine or similar chemical might work in cases where wind erosion is not a factor.

The important reason for keeping the pipe in place is that most damage to pipe occurs when it is moved. It was my experience in 1969 that we had more pipe damage on our 170 acres of hand-move land (about 250 pieces) than on our 520 acres of semipermanent solid-set (15,000 pieces).

There are some caveats that I would like to present about above-ground permanent installations.

1. Make sure sprinkler pipes are well-drained prior to winter. This will save repair welding in the spring.

2. Make sure your water does not contain any harmful minerals or abrasives. Sprinkler pipe can be ruined very quickly by certain water conditions.

3. Make sure the lines are straight. We generally shoot several key lines in with a transit, then we taped the rest of the lines from them. This makes the farming operations much easier.

Speculate on Head Upkeep

I would speculate that sprinkler-head upkeep will be the principal maintenance problem that we have with our installation. Last year we applied about 36 inches of water to our ground. This required about 220 hours of operation of each sprinkler. We operated our hand-move sprinklers about 2,000 hours during the same period; thus, it will take about 8 years of solid-set operation to approximate the use wear of 1 year's normal operation of our handlines. I feel that most of our sprinkler-head wear will be from deterioration of the rubber and teflon as a function of time and exposure to the elements rather than as a function of use.

I feel very strongly that a permanent above-ground installation of solid-set is the best answer to our farming problems. We can preirrigate with it, and can use it for wind control during the period to the time solid-set is normally put in place. The farmer on my land adjusted to the strip-farming concept very quickly and last year we had less than $100 damage to pipe caused by the operation of machinery and equipment.

I am often asked why I didn't go to an underground plastic installation for my permanent solid-set. I must point out that buried plastic has no salvage value in the unhappy event that the system didn't work out.

I also had my system designed to incorporate some semiautomatic features that have been very useful.

Useful Features

First, we designed the mainlines so that we could carry 3,500 gallons per minue to any part of the 520 acres with a minimum of friction loss. This meant using an 18-inch penstock, dividing

into two 14-inch feeders which reduce the 12-inch lines. We have no mainline smaller than 12 inches. This way we can concentrate all our available water during periods of stress on our high value crops.

We plan to keep a reasonable ratio of high-value crops to noncritical crops so that we can best utilize the peripheral benefits of frost protection and heat control that are possible with solid-set under the limiting conditions of available water supply.

Off of this mainline we have 24 valves each opening into a smaller submain to which the sprinkler laterals are attached with no further valving. Thus, by opening a submain valve, we turn on a block of eight half-mile laterals or a block of about 24 acres.

We space our sprinklers 30 feet along the laterals which are 50 feet apart. Thus, a block of 24 acres will contain about 700 sprinklers.

We use 7/64 nozzles which deliver about 2.5 gallons per minute at 60 pounds pressure. Thus, one block requires 1,750 gallons per minute. We have five turbine pumps at our pumping station, each capable of delivering 1,750 gallons per minute at 60 pounds per square inch to our valves.

We must also irrigate the 250 acres of conventional solid-set with these pumps, although through different mainlines, so we reserve one or two pumps for this purpose. This leaves the possibility of either three or four valves operating at all times. With four valves operating and being changed every 4 hours, we can apply 65/100 inch of water per day every day to all crops in the 520 acres.

We can also deliver any needed amount of water over and above the 65/100 inch per day to any valve by merely cutting down on the application to the noncritical crops such as alfalfa. As you know, 65/100 inch per day is adequate water for all but the most critical circumstance.

Can Protect Potatoes

Normally we might expect to have three valves, or 72 acres in early potatoes at the critical frost time early in the year. By concentrating on these three valves, we can protect the potatoes. I feel that the large delivery mains are an essential factor in the full utilization of the potential benefits of solid-set equipment.

We operate these submain valves electrically from centrally located switchboxes. All it takes to change water from one 24-acre block to another is to turn on a switch. This quick operation gives us additional flexibility in the operation of our system. As you can guess, it would be reasonably easy to further automate our operation by installing time clocks and various sensors and feedback devices. This may be useful in certain specialized crops such as grapes, or orchards, but in most row crops and field crops, I feel it is of no value and may in fact be detrimental.

I want the operator farming my land to look at the crop when he changes water, in fact, I hope there would be a few plugged sprinklers so that he will even have to walk out into the field. I feel that a good farmer, looking at and walking in his growing crop is the best sensor, and the most dependable feedback and operations device. I think we are going to have to advance the art of agronomy a considerable extent before a tensiometer or a leaf sensor can be reliably entrusted with the final decision concerning crop watering.

I have briefly described the design of our sprinkler system. As you can tell, it is ideally suited to provide the short, frequent water applications that are necessary for top yield and quality in light soils. An 8-hour watering will completely fill the critical top 2 feet of our soil even using 7/64 nozzles.

The Real Proof

We have designed the system to provide frost protection, as well as other specialized uses. The

real proof of the value of a system must, of course, be the success of the crops that are grown. After two seasons use there are observations that it would be useful to make:

Frost control and wind control do work. We had the opportunity to successfully protect potatoes against a killing frost in early April of 1968. In both 1968 and 1969, we used the system to control blowing dust during severe winds. We have never had to rehill one potato, although we found it necessary to water the potatoes for 10 minutes out of each half hour. This certainly proved that this system can do what it was designed to do.

But in another larger sense, water and the application thereof is not the ultimate answer. In 1968, there were plenty of potatoes around when we were ready to market ours as other people had used water to protect against frost, and those people who were frozen out, or waited until later to plant, ended up with a better price. Indeed the heavy application of water early in the spring caused a rhizoctonia problem in the potatoes which could have cut the yield to some extent. In the same regard, watering to control dust also causes rhizoctonia. I feel a much better answer to wind control would be to build up humus in the soil so that it is not susceptible to wind erosion.

A Heat Wave

In July, 1968, there was an extended heat wave in our area. The thermometer recorded in excess of 100 degrees for 10 or 12 straight days. At this time we utilized our system for heat control.

We concentrated four pumps on 180 acres of potatoes during the afternoon heat. This allowed each set to receive water half the time. The resulting humidity approached 100 percent and the ground and air temperatures were noticeably cooler.

The crop certainly suffered no ill effects from the heat. The humidity caused by heat control, on the other hand, caused a severe early blight problem and, I think, reduced our yield to some extent. In the future I will be more circumspect in the use of water for heat control on potatoes.

On the brighter side we have used our solid-set with considerable success to fertilize the growing crops. But here again there was a certain learning period when we paid a schooling price. In 1968, we used continuous side dressing, injecting fertilizer in small amounts all during an 8-hour set. Because of the low holding capacity of the soil, this fertilizer was distributed over the full 2-inch root depth of the crop. At the next watering, 1½ to 2 days later, any of this fertilizer which was not used was leached to lower depths, out of reach of the central root zone of the plant. As a result, the potato crop showed a nitrogen deficiency in mid to late summer.

I think this continuous method of fertilizing, along with a natural propensity to over water sand if the water is available, was responsible for this problem. In 1969, we changed our method of injection. We would water 7 hours of an 8-hour set then apply the fertilizer over a 15-minute period and wash the plants off the remaining 45 minutes. This kept the fertilizer near the top of the soil horizon, and kept it from being leached out of reach of the plants as quickly.

We also kept closer track of the fertilizer in the plant tissue and gauged the application rate accordingly. In sum, I feel nitrogation is one of the real advantages that accrues to the owner of a solid-set system.

Able to Cut Seeding Back

We have also had excellent results in using the solid-set to establish stands of alfalfa. We are able to cut our seeding rate back to less than 15 pounds and obtain excellent stands. Care must be taken, of course, to provide a good seed bed, and to keep the ground wet at all times during the critical first 10 days.

Many persons wonder how we can afford to water an established stand of alfalfa with a solid-set. My experience is that solid-set justified a considerably higher rent as a percentage of gross income because it substantially reduces the other costs of production. Water management is reduced to just a few minutes a day, sprinkler-moving costs are eliminated and stand-establishment costs are cut because of the forementioned germination efficiency. Only fertilizer and harvesting costs are constant. I do expect alfalfa will compete with potatoes as my long-run leading rent producer.

An interesting application of our solid-set is in creating artificial dew for bailing alfalfa. As you know, alfalfa bales best at a certain moisture level. Many times during the second and third cutting, it is a long wait for a morning when natural dew brings the moisture level to the proper percentage. We baled three cuttings of our five cuttings this year with artificial dew which we obtained by turning our solid-set on at high pressure (70–80

pounds) for 10 minutes or so. Then after a short wait, the hay was ready to bale.

While our artificial dew was not as good as the real commodity, it was certainly more readily available.

I should pass over our worse moments, but one big problem we have in our area is trash in the water. As you can imagine, it doesn't take much trash to plug up a 7/64 nozzle. We have installed two rotating circular screens or "rotary screens" at our canal pumping station. I feel that this cleans up our water enough to make it usable without too many sprinkler-plugging problems. We could expect six or eight sprinklers to be plugged in a valve of 700.

Plugging Avoided

Our conventional solid-set utilizes 9/64 nozzles on 40 feet by 50 feet spacing and I observed no plugged sprinklers in this system all year. I found it useful to put a larger nozzle in the sprinkler on the end of the lines as any trash in the line will naturally move to the end. In addition, this puts a little more water on an area which does not enjoy the benefit of overlap.

We utilize in our system five different types of sprinkler heads from three different manufacturers. I feel it is not in order to single out any one manufacturer as making a superior or an inferior product, but I would comment in general that because of our severe conditions, particularly blowing wind, dust and sand, the smaller, lighter springed sprinkler heads have not proved satisfactory. We have enjoyed excellent results with the old standby models with the new aluminum arms.

I have also found that some of the smaller models should be run at higher pressures than we may be accustomed. My system is designed to run 60 pounds per square inch and I would not recommend running the new, smaller models any lower than that.

Our crops would indicate that we are obtaining a good uniform application rate. In 1969, our Russett Burbank potatoes yield 25 tons per acre and graded out 80 percent plus No. 1's. We obtained 8 tons per acre of alfalfa from a first-year stand, half of which produced no first cutting of any value. On balance we have been successful in growing good yields of high-quality crops, and I have obtained a good return on my investment.

I have been told that the solid-set irrigation system is no panacea, but is merely a tool to be used for increased production and efficiency by the farmer. We have learned the things that can be done and can't be done with a solid-set system and I must say that we have come to appreciate that solid-set is the only way that our ground can feasibly be irrigated.

Thus, I feel that it is more than a mere tool, perhaps it is a panacea. It is, however, a sort of fickle panacea as its flexibility seems to create as many problems as it solves. Perhaps the farmer is still the prime mover in the production system and he must learn to use this panacea, but it is more of a job than it appears at the outset. I will attest to that. # # #

(*Appreciation for reprint permission of this speech goes to Mr. Davin, and the Sprinkler Irrigation Association, Washington, D.C., who printed it with other proceedings of the 1970 conference of the Sprinkler Irrigation Association. Mr. Davin is of the Davin Ranch, Pasco-Richland, Washington.*)

Dredging was planned and all interests considered

Fish and Wildlife at Former Mud Flats

THE management and preservation of Arizona's fish and wildlife involves—

Much more than merely running game surveys and stocking fish. In some cases, it involves agencies other than the Game and Fish Department.

Such are the circumstances surrounding the recent habitat improvement project near Blythe on the Colorado River.

A large backwater located 1 mile below the Blythe bridge was isolated beneficially in 1964 by construction of the U.S. Bureau of Reclamation channel structure which that agency's work plan calls Structure A–7. Along approximately 1 mile of its length, this backwater consisted of an old river meander.

The old meander wandered through a relatively flat delta plain, vegetated with thick, mature stands of salt-cedar, arrow weed, and mesquite. The channel averaged approximately 3 feet in depth and varied considerably in width.

Water was confined between steep, forested banks in the upper end of the channel, but wide shallow areas bordered by sand beaches predominated in the downstream portion of A–7.

In addition to the planned isolation of the old meander during the 1964 channelization, the Bureau installed culverts from the river to the backwater to insure a continuous flow of fresh water to prevent stagnation. However, it soon became apparent that this was not the total answer. A–7, and another backwater "A–10" further downstream, were becoming shallow and vegetation had invaded all but the deepest channels. By 1966, it looked as if these backwaters would disappear completely in the next few years.

Cause of Depth

A study was initiated by the Arizona and California Game and Fish Departments in cooperation with the Bureau of Sport Fisheries and Wildlife to determine the cause of the decreasing depth and find an answer to solve the problem, if possible.

It was found that the absence of the natural scouring action of the river, in conjunction with the continued river-level fluctuation, had permitted water associated vegetation to become established in all areas which were periodically above water levels during the spring and summer months. To further accentuate the problem, the river was cutting a deeper channel which was lowering the level in the backwaters.

In the late summer of 1967, the Arizona Game and Fish Department prepared a plan proposing that one of the Bureau of Reclamation dredges move through this backwater area and deepen the existing main channel and secondary channels. The plans were accepted and construction began in 1968. The project was designed to insure that the entire channel length would become fish habitat.

There were also numerous side channels which were to have small pools at the terminal end. These channels and pools could provide boat and shore anglers an opportunity to escape the turmoil of the river channel, and fish in secluded backwaters.

Dredging would also preserve certain water areas for waterfowl use.

Pulls Slowly

In cutting a channel for a fish habitat, the "Little Colorado" dredge pulls itself slowly through the mudflat area. Looking back from the dredge is the floating tailline made of a pipe under a steel walkway. The pipe carries dredged material to deposit areas on the shore.

The main channel design proposed by the Department provided for a boat entrance at the downstream end, and access to all the side channels. The main channel was to be 50 feet wide, 8 feet deep, with a slight bank slope to the water. There were also to be three sections of the main channel only 24 feet wide.

The overall objective of the proposal was not to create new habitat, but to improve the existing habitat. The deep channels, dredged across large shallow-water areas which had become of little value for fishing purposes, would also decrease evaporation losses during the hot summer months.

Many birds benefit from the improved habitat on Lower Colorado River.

But the Bureau of Reclamation did not follow the Department's proposal in completing A–7. They made conditions even better by creating *more* deep water. They did much more than was suggested for the improvement of the wildlife habitat.

Because the small, vacuum-operating "sand-sucker" dredge programed for the improvements could not handle the thick mats of vegetation and volumes of cattails, a larger dredge with a cutting head was brought into use.

The larger dredge, however, could not move through the originally proposed 24-foot-wide side channels. So the Bureau of Reclamation cut all channels open to 50 feet in width. While no completely dry land was dredged nor additional surface water created, the large expanses of shallow flats—which contributed greatly to evaporation losses during the hot summer months—were eliminated, along with a good deal of the invading vegetation.

Dredging now has been completed in the largest of the two backwaters proposed in the 1967 plans. The completed backwater, A–7, is approximately 1 mile below the Blythe Highway bridge on the Arizona side of the river. Originally proposed for the removal of 106,175 cubic yards of material, backwater A–7, actually had 595,129 cubic yards excavated by the Bureau of Reclamation.

Increased Fish Habitat

The addition of deeper channels through shallow water areas appreciably *increased the total amount* of game-fish habitat, but only time will reveal the full success of this habitat improvement.

A recent visitor survey indicates the area is presently receiving much more fishing pressure than anticipated in preliminary economic evaluations and most of the credit for preserving the A–7 and A–10 backwaters has to go to the Bureau of Reclamation.

Aside from the obvious benefits of preserving wildlife habitat, the Bureau has also provided an unusual experimental feature. The building of fish and wildlife habitat in this manner incorporated planned boat and bank access locations. It created new fish spawning areas and improved waterfowl resting sites.

The project is an excellent example of the need for interagency cooperation which we have stressed in the past. Adequate planning was done. The project was not rushed. All interests were considered. Everyone benefited, including the water users.

The decisions made now and in the next few years will have much to do with determining the quality of life left in Arizona for our children and their children.

Orderly planning, development, managing and preservation of the wildlife resources of the State is our job, as required by law. The Bureau of Reclamation did their part at A–7. # # #

(*We wish to acknowledge reprint permission for this article from Arizona Governor Jack Williams and the editor of* Wildlife Views.)

Oil well work in the county's Poison Spider Creek area.

Rich in oil, agriculture and recreation

Thriving Natrona County, Wyoming

Story and photography by CLYDE DOUGLASS

IF the State of Wyoming was a target, Natrona County would be the bull's-eye. And for very good reasons, many residents of the county believe just that.

Located in the central portion of Wyoming, Natrona County was named for the natron or soda ash deposits found in the area. Its borders form an almost perfect square and contain 5,342 square miles. The county is predominantly plateau lands except for the southeastern portion in the foothills of the Deer Creek Range. Elevations above sea level range from 5,000 to 6,000 feet.

Few counties in Wyoming, if any, can boast of a richer historical heritage than Natrona County. The first white man's cabin built in what is now Wyoming was erected near Bessermer Bend in 1812 by Robert Stuart and his small band of fur trappers.

Father De Smet began spreading the gospel among the Indians in 1840 and undoubtedly averted many later battles between white pioneers and the Indians. It was Father De Smet who first carved his name on Independence Rock and gave it the name, "The Register of the Desert." This huge granite mass stands 193 feet high and covers 27 acres. Nowadays people from all parts of the country travel to see this landmark which more than a century ago was a natural stopping place for emigrants and explorers.

John C. Fremont chiseled his name on Independence Rock in 1843 and later, with Kit Carson as his guide, went on to explore the country along the Platte and Sweetwater rivers.

Wagon Train Crossing

After Fremont, between 1847 and 1855, the Mormons, on their way to the Great Salt Lake

country passed through Natrona County. They crossed the Platte River at the "Mormon Ferry" used by Brigham Young and his followers. Later known as Fort Caspar, the river crossing became the headquarters for soldiers escorting wagon trains on the Oregon Trail. Today Fort Caspar has been restored on its original foundations and offers historical buildings, paintings and artifacts for natives and visitors interested in the Old West.

Certainly the most important aspect of Natrona County's history to lend support to Casper's growth was the discovery and development of the region's rich oilfields.

The first drilling for oil in the county began in 1888 about 3 miles northwest of present day Casper. As America's petroleum needs grew, so did Natrona County's production.

By 1894–95 Casper had its first refinery, a modest operation capable of producing 100 barrels of lubrication oil daily. From this meager beginning Casper has grown to be the hub of the oil and gas industry for the Rocky Mountain region. Nearly every major oil company has established exploratory offices in Casper. More than 400 oil and oil-affiliated companies now operate in the county. Four interstate pipelines either originate or pass through Casper, and three of Wyoming's nine refineries are located in the oil capitol and produce 39,000 barrels a day.

Industry Support

Since the turn of the century the oil industry has attracted businesses and supported Natrona County's economy. By the end of 1967 there were 140 wholesale business establishments in the county—more than 22 percent of Wyoming's wholesale dealers and 54 more than the county with the next highest number. Most of these businesses are industrial, agricultural and transportation equipment sales and the related services.

The second greatest source of income for Natrona County is ranching and agricultural products. Cash income from farms and ranches exceeds $10 million each year.

Ninety percent of the county's agricultural units are small—160 to 300 acres—irrigated farms on the Bureau of Reclamation's Kendrick Irrigation Project west of Casper. The project covers 26,687 acres, of which 90 percent is under cultivation. The leading crop is alfalfa with 14,000 acres in production yearly. Oats, barley and corn are also important agricultural products.

Since the days before statehood, livestock production has been big business in central Wyoming. Today there are about 40,000 head of cattle and 242,000 sheep in Natrona County. Dollarwise the total livestock investment easily exceeds 10 million.

Farmers and ranchers in the area are looking forward to livestock productions to produce an additional income of nearly $1¼ million in the next 12 years. With good management programs agricultural people in Natrona County expect to increase their gross incomes by 10 percent during the 1970's.

Recreation, a valuable asset everywhere in Wyoming, is especially important in urban areas like Casper to fill the needs of an industrial community. It cannot be overlooked economically either. A recent study disclosed that resident hunters and fishermen annually spend over $6 million in the county—nearly $1 million more than sportsmen spend in any other county in Wyoming. During the same period nonresidents normally spend almost a million dollars. The combined total of these expenditures account for the largest total spent on hunting and fishing in a single county in Wyoming.

License Sales Exceed

Resident license sales for deer, bear, antelope, small game, and youth and adult fishing exceed sales in any other Wyoming county.

Game and fish managers in the area attribute these high sales to the easy back country access and the many opportunities for outdoor activities. Nearly half of the land area in the county is public land and there are very few landowners who

A library on the Casper College campus.

charge trespass fees. Opportunities available to the hunters, many of them shift workers in oil and the related businesses, and the central location of Natrona County automatically generate high sales of hunting and fishing licenses.

Hunting is ideal. There's an abundance of antelope and mule deer in most of Natrona County. Elk are found, but limited to the foothills of the Big Horn Mountains in the northwestern portion of the county, in the Deer Creek Range to the southeast, and the Poison Spider Creek area. The county elk population has been estimated to be 350 head.

Upland game birds—chukar and Hungarian partridge and sage grouse—provide bird hunting in certain areas of the county. Along the Platte River and reservoirs, hunters find waterfowl. Cottontails and jackrabbits abound in Natrona's wide open spaces. Coyotes, bobcats and a variety of furbearing animals are hunted and found in the area.

Some of the finest fishing in Wyoming and the Rocky Mountain region is in Natrona County's reservoirs, natural streams and rivers. Mountains to the north and southeast, plains to the east and southwest, lakes, streams and canyons are all within easy driving distance from Casper, providing a year-round setting for fishing enthusiasts.

Reservoir Use

Alcova and Pathfinder reservoirs (which were built by the Bureau of Reclamation), the North Platte River and the mountain streams provide the ardent as well as the inexperienced angler with an opportunity to try his luck in trolling, fly fishing, or bait fishing. During the winter months, brave and hardy ice fishermen can be seen testing their skills and endurance on Natrona County's lakes and reservoirs.

Recreational activities go beyond hunting and fishing, however. The county's lakes and parks offer well-developed and maintained boating facilities. Boating enthusiasts have opportunities to participate in fishing derbies, water-skiing tournaments, powerboat races and regattas each boating season. Visitors from around Wyoming and out-of-Staters are always welcome to complete and participate in aqua events.

In the winter, Casper Mountain comes alive with over-snow machines and winter sports activities. Winter shelter facilities have been constructed in Beartrap Meadow Park and 10 miles of trails have been built. Snow skiers planning an outing in the Casper area find ski facilities to include a 2200-foot Constram T-bar lift at Hogadon Basin, rope tows at both Nursery Ski Run and Hogadon, with warming huts and concessions available. Hogadon Basin ski area has three 600-foot vertical drop runs.

Natrona County

County seat: Casper
County population: 49,623
County area: 5,342 square miles
Major source of income: Petroleum and Agriculture
Average growing season: 129–141 days
Annual mean temperature: 46.0 degrees
Annual average precipitation: 11.25 inches
Average annual snowfall: 72.4 inches
Land ownership:
Private: 1,548,450 acres
Federal: 1,319,060 acres
State & County: 551, 560 acres

Parks in Casper

The city of Casper maintains 11 parks in addition to the 1,000-acre Casper Mountain Park. Within these parks there are three swimming pools, tennis courts, hardball and softball fields, three golf courses, an annual fair, a stock show and a museum.

Not to be overlooked are the opportunities for the artifacts hunter and the rock hounds. Hundreds of square miles of open country surrounding Casper are laden with treasures yet to be found. Jade, moss agate, petrified wood and jasper beds located in the western portion of the county are reputed to be some of the best in the United States. Indian artifacts are found scattered throughout the county.

Natrona County's wealth is not limited to its rich historical background nor its petroleum fields. Newcomers have been attracted to the county by the current uranium discoveries within 35 to 100 miles surrounding Casper. These discoveries have led to the development of five uranium-processing plants, and mines. These facilities are expected to play a major role in the developing nuclear age.

Casper and the surrounding country has its eye on the future and its youth. Testimony to this can be seen in nearly every aspect of Natrona County life. Noteworthy is the interest and pride the residents have in the Casper Troopers. This energetic and precision marching-playing group is recog-

ized as one of the best drum and bugle corps in America.

Casper College, the largest 2-year college in Wyoming, is continually offering new programs in education to meet the challenges and technical advancements of tomorrow.

These growing educational facilities for youth and future leaders of a growing community insure the prospects of Natrona County maintaining its "bull's-eye" position in Wyoming. # # #

(Clyde Douglass, 26, is a staff writer for the Wyoming Game and Fish Commission. He takes writing-photography assignments covering news and features about wildlife and conservation in the State. Mr. Douglass' article first apeared in the Commission's Wyoming Wildlife *magazine, whose editor, George Sura kindly permitted reprinting here.)*

Sunbathing on the dock at Reclamation's Alcova Reservoir in Natrona County, Wyo., are from left, Cindy Fairchild, Peggy Cowardin and Joyce Schindler. The docks and other near-by recreation facilities were constructed by Reclamation Job Corpsmen.

FIFTY YEARS AGO
in Our Magazine

IDAHO STATE GRANGE INDORSES RECLAMATION SERVICE.

At the twelfth annual session of the Idaho State Grange a resolution was adopted, in part as follows:

"Whereas we have full confidence in the integrity, ability, and efficiency of the Federal Reclamation Service, based on their past work, we favor the development of all lands in this State by the Federal Reclamation Service."

Successful Applicant at North Platte Opening Gives Views.

The following extracts are from a letter received recently by Mr. C. H. Fitch, chief clerk of the Reclamation Service, from Capt. James E. Fitzpatrick, one of the 80 successful applications out of 3,298 ex-service men who applied for a farm at the opening on the North Platte project, Nebraska-Wyoming, on March 5:

My Dear Mr. Fitch: At the instance of Miss de'Lauder, of the Internal Revenue Bureau, it may be of interest to you to have some first-hand impressions of a person interested in and fortunate enough to have been successful in the recent land drawing held at Torrington, Wyo., for the benefit of ex-service men.

Real sincere interest in this small project is evidenced by the fact that 3,298 applications were made for 80 parcels of land, and it seems a great pity that only 1 man in 40 should have been successful in obtaining the right to homestead a piece of this land.

DIRECTOR DAVIS RECEIVES NEW HONORS.

Arthur P. Davis. Director of the Reclamation Service, received the degree of Doctor of Engineering from Iowa State College on June 9, 1920. On the preceding day Mr. Davis gave an address to the engineering faculty and alumni at the Engineering Symposium, which was a feature of the semicentennial celebration of the college.

MORRIS BIEN NEW ASSISTANT DIRECTOR.

Morris Bien, for the past year assistant to the Director of the Reclamation Service, has been advanced to the newly created position of assistant director, effective June 1, 1920.

Be a good friend to your cow; she is a good friend to you.

HOW RECLAMATION AIDED YAKIMA VALLEY.

In the course of a speech in the House of Representatives on June 5, 1920, Representative John W. Summers, of Washington, said:

"The value of the crops harvested in the Yakima Valley last year is conservatively estimated, according to reliable figures which I shall shortly quote in detail, at $45,602,576, and I am here to say that had it not been for the passage of the reclamation act of June 17, 1902, and the subsequent reclamation work in that valley by our Government, the value of its crops last year would have been reduced about $40,000,000.

"Here, then, we have a concrete example of forty millions in one year added to the country's production and wealth as a result of Federal reclamation work on the arid lands of one county in my district."

Montana, Lower Yellowstone project.—We are indebted to Schaefer & Newlon, of Fairview, Mont., for some very interesting pictures and cheering news of the Lower Yellowstone project.

Production in the Lower Yellowstone Valley can be increased 400 to 500 per cent if all the land is put under intensive cultivation. Fairview is located within 2½ miles of the geographic center of the valley and could easily support 1,000 farmers instead of 150 as at present.

NEW CHIEF ENGINEER.

Effective April 1, 1920, the official designation of Mr. F. E. Weymouth has been changed from chief of construction to chief engineer.

Reclamation Babies Win.

Just to show that our knowledge of "better babies" is gained first hand, you will be interested to know that in the better-baby contest just closed in this city, the prize for the best baby brothers was awarded to Paul and Francis Leverone.

Paul and Francis also received honorable mention in the photographic baby contest held by the Washington Post in 1918.

The proud father of these wonderful children is Mr. P. J. Leverone, of the Reclamation Service Drafting Division, Washington, D. C. Their picture appeared at No. 87 on the back page of the May Record.

Technology changes came, but it's still . . .

ZANJEROS—Tried and True

by DAVE GURZENSKI, Editor of *Current News*, Phoenix, Ariz.

THE new water customer waded across her yard, her pants hiked up above her knees, and spoke to the man in the white hard hat as he surveyed the row of lawns being irrigated.

"You must be from the Salt River Project, aren't you? What exactly is your job, anyway?"

"I'm a zanjero," he replied, watching her children cool themselves in a full-fledged water war.

"A zanjero? I thought zanjero meant 'ditch digger' in Spanish. It looks like all the canals are already dug so why don't they change your title?" she questioned.

"I suppose the name just stuck," he smiled, hopping in his truck and moving on to the next block to check the water flow.

The housewife's query is repeated frequently by others unfamiliar with the early history of Project Zanjeros. The reasons why the title "just stuck" can be learned from Herb Greer. Now superintendent of Irrigation Operations, he worked as a truck driver and zanjero during the 1930's when a zanjero's job was 24 hours a day, 7 days a week.

"Sixty of us managed to cover the entire canal system in those days," recalls Greer. "Today that sounds like quite a feat, but we looked at it as a job that had to be done. The first zanjeros before us had it a lot rougher than we did, so we had no right to complain."

Keeping the Job

Training for the zanjero was nonexistent. If you had a strong back and could stand the blistering

Zanjeros using steam drill in 1907.

heat, the position was yours. Keeping the job was a little more difficult.

"Each zanjero was assigned a division, same as the zanjero today, only now we call it 'an area,'" explained Greer. Since it was necessary to collect all water orders from the farmer himself, he had to live right in his division. In time of emergencies, he was there when needed, in a little project-provided house on the bank of the canal.

Some of the first houses were little more than wooden shacks, covered by tin roofs. It wasn't until the zanjeros began to pay rent ($11 a month) that the houses became more livable.

Early construction of the canal system wasn't all done by zanjeros with pick and shovel. In 1907 steam drills were being used in the bottom of the Arizona Canal, making the digging a little easier.

Once the water began to flow through the system the zanjero's problems multiplied. The first headgates and sluiceways were feeble attempts to regulate the amount of water flowing into the canals. Composed of wooden planks, bundles of mesquite, mortar and stone, they were the zanjero's only control of the mighty Salt and Verde Rivers. The rivers fought against the restrictions. Their wrath was disastrous. Months of labor spent in building a headgate could be washed away in a matter of minutes by a sudden storm.

When the zanjero wasn't worried about floods, it was the drought. Water was liquid gold to the farmers who depended on the trickle that ran down the furrows of their fields. At times the zanjero was forced to bear arms in order to assure the proper delivery of water to the land.

Simple—Complex

Today certain areas of the zanjero's job have been simplified by technological advancements; other areas grow complex, making additional training necessary for the "ditch walker" in 1970.

Before a zanjero is assigned to the field, he must complete a rigorous orientation training course which contains such topics as geographics, mapping, transmission communications, storm control, measurement and first aid. He must learn a whole new vocabulary. He must possess a working knowledge of every dam, headgate, canal and lateral within the irrigation system.

"So the job requires a lot more than just a strong back as it did years ago," says Greer. "Things are changing rapidly and the zanjero must keep abreast of the changes. If his area makes the transition from farm to urban acreage, for example, he

Modern zanjero at work.

is responsible for the same volume of water yet a greater number of subdivision accounts."

The transit change to a 8-hour shift in 1968 improved scheduling and enthusiasm among the men, according to Greer, and the latest union increase in wages for all zanjeros makes the position even more attractive.

The zanjero's horse has been replaced by a pickup truck, and canal gates operated by smooth-turning hand wheels regulate the correct amount of water. Also the crank telephone has been replaced by the short-wave radio permitting the man to keep in constant contact with water operations near and far, and making it unnecessary for him to live within his territory these days.

Yet a few things remain the same for the zanjero, says the irrigation superintendent. "He has to possess that same determination those zanjeros had when this system first began. He has to have water in his blood," stressed Greer. "Although the technology of his job has changed immensely in the last decade, his main purpose remains the same—getting water to the shareholder."

"There's a lot of meaning behind that title. The men called zanjeros have been through plenty to earn that name. And we don't intend to give it up." # # #

(*Appreciation for use of this article and photographs go to author Dave Gurzenski, and to the* Current News *where they first appeared.*)

By a dedicated teacher who died untimely last February

Job Corps is Vital —Here's Why

by **FRANCIS PAULA HESTING, SP**
Collbran Job Corps Center, Colo.

THE "teacher" in me is continually amazed at the amount of illiteracy we discover in the men who come to Collbran Job Corps Center. What we see here must be multiplied ad infinitum to get the educational picture of our disadvantaged youth. *Why?*

This "Why?" becomes more vehement as we work with the corpsmen. A good example of what I mean is the young man who came from a small town in Florida. Eddie came to our Center and after placement tests was put in the very beginning of Programed Reading. I know, first hand, that he could neither read nor write, and the printing he did was much like that of a kindergarten child.

Eddie had gone to the ninth grade before he dropped out of school. Each time Eddie passed on to a new study area I felt as though I myself had graduated. This corpsman has made up his mind that he will get his GED, that is education which will enable him to take the test which in turn allows him a certificate equivalent to a high school diploma. I believe he will. But why did he have to fail for so many years?

The thing that makes Job Corps education fascinating for me is that here we work in a climate of success. We do not seek to know the reason why a young man does what he does, we take him as he is here and now and work with him.

Need To Talk

There is individualized instruction when it is needed, and there is the opportunity for a student to talk over a difficulty just when he has the need to talk. Each staff member at Collbran is continually reminded by the head counselor, "Every member of this staff is a counselor." The corpsmen are quick to sense this philosophy.

The other day I was bending over the GED file when I felt a poke in the back, I turned around fully expecting to see Alice O'Leary, one of the other teachers, only to discover a new corpsmen. He looked very serious and very troubled as he said, "Come here, will ya, I have to know something."

The director of our center, Mr. Carpenter, has made it clear to all of us that he wants each corpsman treated fairly. He believes that when a difficulty arises it should be settled at the level at which it happens.

I was impressed the other day at the staff meeting when he said, "Just put yourself in their places. Keep this in mind—these men are people. Each one of you should know that it takes a special kind of person to work with the men, and if our corpsmen don't make it here, for many of them, it is a last chance."

One night Mr. Carpenter came to the arts and crafts building as I was about to leave. We stayed and had quite a long talk about the men, attitudes here, and the kind of people who should work with corpsmen.

People Not Ready

I got the feeling that he was deciding about two of our men who got into trouble at Grand Junction. The offense was not too serious, but the people around here are not ready to accept men from Job Corps and the things these men do are usually magnified at the expense of the whole program. Maybe all of us should begin to understand that persons fail not once, but twice, and even three times, especially the kinds of persons who enter Job Corps for help.

As long as the corpsmen know they are not accepted in the local community, and here at Collbran they are not, much of our teaching lacks the assurance which comes only from experience. At present we can only warn our men that they have to prove themselves before they are accepted in society.

Many corpsmen know the truth of this because some of our alumni have been placed at good jobs at the termination of their Job Corps training, and what these men have written back to the men still here carries a great message of assurance.

I don't remember just how I felt about working at the Job Corps Center other than to hope I could succeed, and that I might learn things which would help me in teaching. I have learned much.

I have learned the humility which comes from working with those who are humble. Corpsmen, at least in the classroom, are charming because of this quality. They cooperate, and as a rule they do this with a sense of humor which makes them fun to work with.

I have learned that everyone is lonely and cries out to be understood. This has made me turn to God and plead for wisdom, the kind of wisdom which, often in spite of oneself, is saying just the right thing in a given situation.

Much To Teach

I have come to know that every man I teach has much to teach me. He has had experiences which have made him very wise in many fields. I see our corpsmen literally moving mountains when they build our dams.

I hear them talk about heavy equipment with great understanding of the principles involved. I see the church they have painted, and I watch with interest the house they are building—and I know that all the knowledge is not in books, but I hope that I can help them get enough of what is in the books to enable them to get the jobs which will make use of their skills.

I have learned that there are wonderful people working in Job Corps. People like Alice O'Leary, who spends endless hours of overtime without thought of pay, or folks like our two VISTA workers, Mrs. Drayer and Mrs. Ouithant, who give music lessons on their free time because they recognize talents no one else ever found before, or they teach the corpsmen the kind of manners which will make them more acceptable among other persons.

I have seen Mr. Robatham, our principal, going over his records so that he might find all the reasons why a corpsman should have another chance. I have taken the coffee which Mrs. Karlson prepares with gratitude, because she knows what "Just a little drink will do in the middle of the morning."

Courage To Tell

I have listened to our faculty discuss experiences in driver education, and I have applauded them when they have had the courage to tell the officials that they were discriminating.

It might be inspiring for all teachers to hear the views of our Mr. Young. This man gave up an opportunity to play basketball on an international team when he returned from Vietnam because he thought Job Corps needed what he had to give.

Our corpsmen are taught both in the classroom and in the field by people who believe that Job Corps can help these young men become successful citizens.

The staff is encouraged to work as a team because each department has need of the support of the other. The program has frequent visitors from Washington, D.C., who evaluate the work done here in order to judge the worth of Job Corps.

Since no program is perfect, I am sure ours must have weaknesses, but Job Corps has a right approach. It reminds us that these are human beings who are potential failures if they are not helped here and now, and then it tries to secure ways and means to get that help. # # #

(The author, Sister Francis Paula Hesting, was a teacher at the Bureau of Reclamation's Collbran Job Corps Center in Western Colorado. She was highly respected and devoted long hours to her work at the Center, which seems to have contributed to her untimely passing last February 23.)

Instructor Francis Paula Hesting at the work she enjoyed. Students are from left, Larry Smith, Clyde Helm, and John Romero.

Potential Water Project in Asia

A feasibility report on the initial stage of the 'a Mong project in Southeast Asia has been pre-ented to the Committee for Coordination of In-estigations of the Lower Mekong Basin and its nember governments by the Department of the nterior and the Agency for International Devel-pment.

This $1.16 billion project is shown to be conomically feasible with a ratio of annual bene-its to annual costs of 1.6 to 1 for a 50-year period f analysis and a ratio of 1.67 to 1 for a 100-year eriod.

The comprehensive report represents the com-ined efforts of many agencies and individuals.

"The Pa Mong Stage One Feasibility Report" nay be examined at Bureau of Reclamation offices n Washington, D.C., and Denver, Colo., and in nany libraries. It was prepared in limited supply y the Bureau for the Committee and AID. Copies re not available for general distribution.

The project plan envisages that all costs of the Pa Mong Project, stage 1, including facilities for ower, irrigation, domestic, municipal and in-lustrial water supply, could be recovered from stimated power revenues in 50 years at 6 percent nterest with a firm energy rate of 4.87 mills per ilowatt.

The Mekong is one of the great rivers of the world. The governments of Cambodia, Laos, Thailand and Vietnam, countries through or past which the Mekong flows, requested the United States in 1961 to make the studies and investiga-tions which led to preparation of the feasibility report. The report has been carried to completion of the first stage in fulfillment of this request and as a step forward in furthering economic de-velopments and stability in the several nations involved.

The Pa Mong Project area lies on both sides of the Mekong, where the river forms the boundary between northeast Thailand and northwest Laos. Pa Mong damsite would be about 12 miles up-stream from Vientiane, Laos. One dam abutment would be in Laos and the other in Thailand.

To create one large reservoir there would be two satellite dams on adjacent watersheds, Nam Lik and Nam Mong. The reservoir would have a storage capacity of about 100 billion cubic meters and active storage capacity of 86 billion cubic meters.

The stage one powerplant in Pa Mong Dam would have ultimate installed capacity of 4.8 million kilowatts, with initial capacity of 1.2 million. Future expansion similar to that now underway at Grand Coulee Dam in the State of Washington would provide for a total capacity of over 10 million kilowatts.

The Stage 1 plan calls for irrigation water service to 11,420 hectares (28,500 acres) of land in the Vientiane Division in Laos and 31,580 hectares (78,900 acres) in the Huai Mong Division in Thailand.

"The Mekong River is one of the largest single natural resources in Southeast Asia," the report says. "The Pa Mong Project will greatly affect the regimen of the river and will have a tremendous influence not only on the immediate project area, but on much of Southeast Asia."

The report is now being studied by the Mekong Committee and the member governments to determine future plans and sources of funding to implement the project. # # #

More Than Ever

Gentlemen:

I do, indeed, wish to continue receiving *Reclamation Era* to which I have subscribed for several years. Since my retirement the magazine has, in fact, meant more to me than ever.

With reference to content, appearance, etc., I think it is a fine magazine. The wide range and scope of subjects presented are always interesting; the non-technical style of writing presents relaxed and enlightening reading.

HELEN QUINLAN
Alpine, Calif.

NEWS NOTES

Groundbreaking on Garrison Diversion Project

Groundbreaking ceremonies on the first 15.3-mile segment of the 74-mile McClusky Canal on the giant Garrison Diversion project, N. Dak., were held May 16. Reclamation Commissioner Ellis L. Armstrong was principal speaker for the event held at the Jon Sparrow farm southwest of McClusky.

The $7,991,331 construction contract was awarded last April 2 to William Clairmont, Inc., Bismarck, N. Dak.

The Garrison Diversion unit is planned ultimately to irrigate 250,000 acres in North Dakota and supply water for municipal, industrial and recreational uses.

Award of a $2,898,612 contract for construction of a second section of the McClusky Canal and related work was announced on June 19. This work will be on 2.3 miles of unlined canal.

"This project will demonstrate the enhancement of the environment that can be accomplished by careful planning and close attention to construction operations," Commissioner Armstrong said.

Dedication of Glen Elder Dam

Glen Elder Dam, which was started in 1964, was dedicated at ceremonies held June 6. Reclamation Commissioner Ellis L. Armstrong gave the dedicatory address.

Construction of the earthfill dam, a 115-foot high embankment with a crest length of almost 3 miles (14,960 feet) was completed February 14, 1969.

Glen Elder Dam will become one of the major flood control structures in the Kansas River Basin, and will provide nearly two-thirds of the flood control capacity needed on the Solomon River to protect downstream lands and such population centers as Manhattan, Topeka, and Kansas City.

The dam is part of the $62 million multipurpose Glen Elder unit of the Bureau of Reclamation's Missouri River Basin project. The unit will provide an active conservation capacity of about 213,000 acre-feet and of this about 2,000 acre-feet (652 million gallons) of water annually to supply the city of Beloit, Kans.

The remainder of the stored water will be used for a future irrigation water supply as well as water quality control. Nearly 35,000 acres of land and water surface will provide water-oriented recreation opportunities for fishermen, hunters, boaters, swimmers, and water skiers.

The need for building Glen Elder Dam was demonstrated by the devastating flood in the Kansas River Basin on July 9, 1951, and by severe droughts during the mid-1950's. Flood control benefits alone are estimated at $2,315,000 annually. The partially completed structure was credited with preventing $280,000 in flood control damages in 1968.

Miss Pam Hilson, employee at the Third Powerplant at Grand Coulee Dam, Wash., examines a model of the facade for the new powerplant. It represents the 85-foot-high face of the structure designed by Marcel Breuer & Associates architectural firm of New York City.

Water Transport in Texas

Approval of a Reclamation repayment contract covering a loan of $727,000 under the Small Reclamation Projects Act to the Santa Maria Water Control and Improvement District, Cameron County No. 4, Santa Maria, Tex., was announced last June.

The loan will be used to finance rehabilitation and lining of 5.4 miles of canals, replacing 10 miles of open laterals with underground pipe, minor improvements to the pumping plant, and provision of water-measuring devices.

Total cost of the project is estimated at $748,100. 'he District will contribute $21,100 in the form f rights-of-way, administrative supervision and erical services. Organized in 1917, the District is cated near the western edge of Cameron County 1 the lower Rio Grande Valley.

Repayment is to be made in 41 successive annual istallments. The annual payments will range from .609 percent of the loan obligation for the first 7 ears to 2.71 percent for the 11th through 40th ears.

There are currently no land holdings in excess of 60 acres in single ownerships and there are no unicipal and industrial water users.

lew Adviser on Environment

Elwood A. Seaman has been named by Commisoner Armstrong as assistant and adviser on cological and environmental matters.

Mr. Seaman will advise the commissioner and enerally supervise the Bureau of Reclamation's ctivities relating to the National Environmental 'olicy Act of 1969 and coordinate intrabureau and itergovernmental relations in carrying out enironmental and ecological aspects of the Bureau's rogram.

Joining Reclamation on May 4, Mr. Seaman has een advisor on natural resources and environent matters in the Air Force since 1957. He is nmediate past president of the American Fishers Society, and has been active in Boy Scout afairs for many years.

:loud Seeding Effort for ahoe-Pyramid Lake Area

A pilot 5-year cloud seeding program to increase rater supplies in the headwaters of the Lake Tahoe nd Pyramid Lake areas in California and Nevada ras announced early in June.

A major beneficiary is expected to be Pyramid ,ake and the Pyramid Lake Paiute Indians on the eservation surrounding the lake. The lake surace has been dropping for many years at an averge rate of approximately 1 foot a year.

The operational research, concentrating the first ear in the Truckee Basin, will be carried out by he Desert Research Institute (DRI) of the Uniersity of Nevada under contract with the Bureau f Reclamation.

The Commissioner of Reclamation has been ommissioned by the Secretary of the Interior to provide for the research, working through its Office of Atmospheric Water Resources. The program was recommended by the Pyramid Lake Field Task Force.

Estimated cost of the 5-year program is $900,000.

Water Service Approved

Approval of a contract under which the Thomes Creek Water District, in California's Sacramento Valley, will be provided water from the Corning Canal has been announced by the Department of the Interior.

The Thomes Creek Water District is about 2 miles northwest of Corning, Calif. The Corning Canal of Reclamation's Central Valley project traverses the district in a north-south direction. The district has an area of 2,417 gross acres of which over 1,800 acres are expected to be used for agricultural production.

Hot, dry summers and cool, moist winters are characteristic of the general area, with an average rainfall of about 20 inches annually. Due to an insufficient groundwater supply, it is planned that the entire water requirement of the district will come from the Corning Canal.

Under the contract, the Bureau will furnish a maximum of 8,400 acre-feet of water during any year.

The district was served water by Reclamation during the 1968 and 1969 irrigation seasons under temporary contracts. In 1968, about 1,300 acres were irrigated.

The district's landowners have constructed their own distribution system. Each individual or group of individuals is responsible for the distribution of water to the land from various turnouts along the Corning Canal.

Industrial Water From Yellowtail Unit

A contract for sale of 40,000 acre-feet of water per year to the Peabody Coal Co. from the Yellowtail Unit of the Missouri River Basin project in south-central Montana was executed last June.

Signing of the contract was another forward step in a marketing program under which 110,000 acre-feet of water in Bighorn Lake was set aside for industrial use to encourage development of coal deposits on Indian reservations.

The lake was created when the Bureau of Reclamation constructed Yellowtail Dam on the Bighorn River. The lake is in both Montana and Wyoming.

Peabody, which has headquarters in St. Louis, Mo., has acquired coal exploration permits on the Crow Indian Reservation in Big Horn County, Mont.

To date, under the water marketing program, the Bureau of Reclamation has entered into contracts to supply 383,000 acre-feet of water per year from Bighorn Lake for industrial use in Montana and Wyoming.

Atmospheric Water Resources Report Issued

The 1969 annual report: "Project Skywater," prepared by Reclamation's Office of Atmospheric Water Resources, was recently distributed to water resources centers, depository libraries. The report presents activities and accomplishments of the Bureau's program and includes summaries of research contractors' activities relating to the program.

Guide for Reservoir Use by Houseboats

The Bureau of Reclamation is taking a leadership role in efforts to prevent pollution of water in its reservoirs by sewage from houseboats.

As direct responsibility for recreational management at most of Reclamation's reservoirs in the West has been transferred to other Federal and non-Federal agencies; the cooperation of those agencies is being requested in this effort to protect the environment.

Policies in regard to houseboats on reservoirs which are under recreational management by the Bureau of Reclamation are:

1. Where facilities or provisions are not available for onshore sewage disposal, houseboat use should be prohibted. Sewage disposal in reservoir water is unacceptable, and practices at each reservoir should be reviewed in this regard.

2. There should be regulations pertaining to power and other capabilities of houseboats to avoid damage resulting from weather hazards. Because of the unusually large exposure above the waterline, power needs for houseboats usually are larger than for other types of boats to enable them to make headway against high winds. The regulations should depend on local conditions.

3. There should be time limitations relative to the use of each houseboat for individual trips and for the season. Care is needed to prevent permanent residence by houseboat users. The usual practice of limiting single-trip use to a 14-day period is believed appropriate in most instances.

4. There should be regulations to control mooring sites for houseboats in order to eliminate undesirable interference with public use for other purposes.

5. There should be strict regulations to prevent disposal of litter from houseboats into reservoir waters, in addition to regulations pertaining to sewage disposal, since houseboats usually include living accommodations designed for continuous occupancy.

"Each regional office is to work with recreational management agencies to ensure that appropriate attention is given to these policies as well as any other applicable considerations because of local conditions," said Commissioner of Reclamation Ellis L. Armstrong.

"With appropriate controls and facilities, we believe houseboat use is entirely proper on Reclamation reservoirs.

"We anticipate that our efforts to protect the waters in our reservoirs in the West will be welcomed by the people who use them for recreational benefit as well as by others who receive water service as a result of the impoundments," said Commissioner Armstrong.

Recreation Areas Annual Permits Valid

The separate 1970 annual recreation area permits issued by the National Park Service, Bureau of Sport Fisheries and Wildlife, Forest Service, and Bureau of Land Management will be valid at all designated areas administered by those agencies, including National Recreation Areas at Bureau of Reclamation reservoirs.

Extension of the Operation Golden Eagle Program until December 31, 1971, was approved by Congress, but passage came too late to make the nationwide Golden Eagle Passport available in 1970. The Department of the Interior has advised Congress that it plans to issue a new Golden Eagle Passport which will be valid for calendar year 1971.

Annual permits issued by the above agencies sell for $7 and are valid until December 31, 1970. # # #

Reservoir Environment

An enigma erupts from the desert.
Where once there was heat and desolation,
Now cool serenity prevails.
Where once the withering sun burned down to scorch
The barren earth, a soft carpet of green
Luxuriously lies underfoot.
Where once no living creature found a home,
Now bountiful existence is the norm,
And so men are recreated.

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON
(Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
Herring Plaza, 317 East Third
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has carried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form may be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

FOR USE OF SUPT. DOCS.	

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

Enclosed find $______________ (check, money order, or Documents coupons). Please enter my subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents per single copy; (50 cents additional for foreign mailing).

Name ____

Address____

City, State, and ZIP Code ______________________________

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6777	Colorado River Storage, Colo.	May 1	Furnishing, inspecting installation, and making operating checkout of programmable master station supervisory control equipment for control of Morrow Point powerplant and Rifle and Midway substations from Montrose power operations center.	TRW International Controls Corp., Houston, Tex.	$367,997
DS-6799	Central Valley, Calif.	May 25	Four motor-driven pumping units for Contra Costa pumping plants No. 1, 2, 3 and 4. Schedule 1.	Hitachi America, Ltd., San Francisco, Calif.	238,630
DC-6800	Navajo Indian Irrigation, N.M.	Apr. 2	Construction of 2.5 miles of concrete-lined Main canal and two siphons.	J. D. Abrams, Inc., El Paso, Tex.	2,031,037
DS-6802	Southern Nevada Water, Calif.	Apr. 7	Furnishing and installing supervisory control, automatic control and telemetering systems for pumping plants, forebay tanks and twin reservoirs near Boulder City, Nev.	Madsen Co., Division of CEME Corp., La Mirada, Calif.	193,600
DC-6803	Fryingpan-Arkansas, Colo.	Apr. 10	Construction of 2 miles of Nast tunnel access road.	National Construction Co. Inc., Boulder, Colo.	229,870
DC-6804	Gila, Ariz.	Apr. 16	Construction of 7 miles of pipelines for South Gila Valley unit distribution system, Part 2.	Gunnison Contractors, Inc., Phoenix, Ariz.	736,776
DC-6805	Central Valley, Calif.	May 14	Construction of 29.7 miles of pipelines for Westlands Water District distribution system, laterals 29, 30 and 31.	Granite Construction Co., Watsonville, Calif.	6,228,165
DC-6806	Missouri River Basin, Mont.	May 25	Construction of stage 02 additions to Custer substation.	United Power, Contractors and Engineers, Seattle, Wash.	287,736
DC-6808	Missouri River Basin, N. Dak.	May 20	Construction of stage 03 additions to Carrington substation.	B & A Electric Co., Inc., Sacramento, Calif.	232,727
DC-6810	Columbia Basin, Wash.	June 8	Construction of concrete lined EHV cable tunnel and grading for 500-kv cable spreading yard and 500-kv switchyard, Grand Coulee third powerplant.	Vinnell Corp., Dravo Corp., Lockheed Shipbuilding and Construction Co., and Mannix Construction, Inc., Alhambra, Calif.	4,660,547
DS-6813	do	June 30	Six 13- by 20.11-foot reverse-flow, wheel-mounted gates for Grand Coulee pumping plant.	Star Iron and Steel Co., Tacoma, Wash.	388,222
DS-6814	do	June 19	Six hoists for 13- by 20.11-foot reverse-flow, wheel-mounted gates for Grand Coulee pumping plant.	Remco Hydraulics, Inc., Willits, Calif.	146,642
DC-6815	Southern Nevada Water, Nev.	June 2	Construction of 34.5 miles of buried and 3 miles of aerial control cable system.	AMCO Electric, Altadena, Calif.	152,550
DC-6818	Missouri River Basin, N. Dak.	June 17	Construction of 2.26 miles of unlined McClusky canal, Reach 3C.	Oil Field Service Co., Inc., Tioga, N. Dak.	2,898,512
DC-6820	Fryingpan-Arkansas, Colo.	June 19	Initial construction for Pueblo dam	Dravo Corp., Burlingame, Calif.	5,143,349
DC-6824	Colorado River Front Work and Levee System, Calif.	June 30	Construction of baffled apron drop for Laguna dam.	John Murphy Construction Co., Spring Valley, Calif.	381,293
DC-6827	Colorado River Storage, Ariz.	June 12	Constructing concrete elevator shaft and furnishing and installing hydraulic service elevator for Glen Canyon powerplant.	Jerico Construction Co., Murray, Utah.	114,400
100C-1094	Columbia Basin, Wash.	May 18	Construction of 9.9 miles of buried pipe drains and deepening wasteway channel for D88-82 and D88-78 drain systems, Block 88.	M & J, Inc., Moses Lake, Wash.	247,086
100C-1097	do	May 13	Construction of 19.2 miles of buried pipe drains for Block 82.	J B & C Co., Scottsdale, Ariz.	320,858
100C-1105	do	June 26	Construction of 8.1 miles of buried pipe drains for D46-180, -181, -204 and -294-2 drain systems, Block 46.	John M. Keltch, Inc., Pasco, Wash.	124,088
400C-443	Eden, Wyo.	June 30	Construction of earthwork, earth lining, and structures for modification of 9 miles of Farson area laterals.	Brasel and Sims Construction Co., Lander, Wyo.	201,318

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

U.S. GOVERNMENT PRINTING OFFICE:1970 O—388-471

RECENT BID REQUESTS*

Project	Description of work or material
Central Utah, Utah	Constructing Currant Tunnel, about 1.7 miles long, and Layout Tunnel, about 3.2 miles long. Alternative schedules for tunneling will allow construction of either a 10-ft-diameter, concrete-lined houseshoe section or a 10-ft 4-in. diameter concrete-lined circular section. The tunnel support systems are to be either steel ribs or rock bolts. Currant Tunnel is to be driven from the downstream portal. The Layout and Waterhollow Creek Siphons will be 10-ft 6-in. diameter monolithic concrete pipe, with a maximum head under 50 ft. Layout Creek Siphon will be about 200 ft long. Waterhollow Creek Siphon will be about 290 ft long. Reinforced concrete access structures will be required at the inlet and outlet portals of Currant and Layout Tunnels and the inlet portal of Waterhollow Tunnel. The Layout diversion will consist of a diversion dam on Layout Creek and about 3,000 ft of 18-in.-diameter pipeline and about 1,400 ft of 15-in.-diameter pipeline. The Waterhollow diversion will consist of a diversion dam on Waterhollow Creek and about 600 ft of 21-in.-diameter pipeline. The pipe on both Layout Diversion and Waterhollow Diversion may be either concrete, pretensioned, asbestos cement, or steel. Work will also include constructing 2.9 miles of access roads. About 4 miles of Duchesne.
Do	Constructing Soldier Creek Dam, a zoned earthfill structure about 250 ft high and 1,290 ft long. The lower outlet works will consist of an intake structure, a 6-ft-diameter tunnel, a gate chamber, an 8-ft-diameter horseshoe tunnel and a covered stilling basin. The upper outlet works will consist of a two-level intake structure, a 6-ft-diameter tunnel, a gate chamber and adit, an 8-ft-diameter horseshoe tunnel, and a covered chute and stilling basin. A shaft house and shaft will provide access to both outlet works gate chambers. Work will also include constructing 7.4 miles of East Side access road, an access road extension, and a service road. On Strawberry River, 39 miles southeast of Heber.
Central Valley, Calif.	Constructing 3 ft of additional height on the existing concrete lining of about 8.3 miles of the San Luis Canal, and adding concrete to the walls and gate sill of an existing reinforced concrete check structure. About 20 miles south of Mendota.
CRSP, Wyo	Additions to the Archer Substation (Stages 02 and 03) will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing two 230-kv power circuit breakers, and associated electrical equipment. About 10 miles east of Cheyenne.
Columbia Basin, Wash.	Constructing concrete foundations; furnishing and erecting steel structures; installing three 525-kv autotransformers, one 230-kv circuit breaker, and associated electrical equipment. Grand Coulee 230-kv Switchyard at Coulee Dam.
Do	Constructing about 1,450 ft of buried pipe and 700 ft of open wasteway, Block 13; 3,900 ft of buried pipe wasteway, Block 16; modifying a turnout, Block 17; constructing 2,100 ft of buried pipe wasteway and a turnout structure, Block 2; placing graded gravel bank protection on one bank of Potholes Canal between Stations 2217+00 and 2256+00; constructing facilities to serve Unit 3, and bank protection on PE16.4 Wasteway, Block 19.
Do	Constructing about 12 miles of buried pipe drains and bank stabilization on RB4H2 Wasteway, Block 82; constructing about 13 miles of buried pipe drains, Block 46; constructing about 12 miles of buried pipe drains, Block 20; and constructing about 13 miles of buried pipe drains, Block 72.
Do	Furnishing, installing, and testing two vertical-shaft, 3-phase, 60-hertz, hydraulic-operated motor-generators having a synchronous motor rating of 67,000 hp at 200 rpm, 13,200 volts, 100 percent power factor, and a generator rating of 50,000 kva at 200 rpm, 13,800 volts, 100 percent power factor. Grand Coulee Pumping Plant, Units P/G7 and P/G8.
Do	Three generator voltage isolated-phase bus structures rated 15 kv, 31,000 amp, including cooling equipment, grounding switches, and generator surge protective equipment.
Do	Furnishing and installing one 1,900-ton gantry for Grand Coulee Third Powerplant. Estimated weight: 2,000,000 lb.
Do	Furnishing, installing, and testing two armature windings for two main unit generators for Grand Coulee Powerplant.
Columbia Basin, Wash.—Con.	One 3-phase, 105/140/175-mva, 230- to 13.8-kv, OA/FA/FOA power transformer for Grand Coulee Pumping Plant.
Fryingpan-Arkansas, Colo.	Constructing Hunter Tunnel (first reach) about 4.4 miles long. Alternate schedules for tunneling will allow either a horseshoe-shaped or circular section, with an unlined "A" line diameter of 8 ft 6 in. The tunnel will be nominally unlined with shotcrete specified for support. Steel rib supports will be specified for certain reaches. No formed concrete lining will be required in this contract. The tunnel will be driven from the outlet portal and will terminate underground near Hunter Creek. A 55-ft-tall vertical access shaft will be driven to the surface from the tunnel at Hunter Creek. The 30-cfs Sawyer Diversion will consist of a diversion structure, a 3,000-ft-long pipeline, and a Parshall flume. Tunnel outlet portal on Chapman Gulch, about 32 miles east of Basalt.
Do	Constructing Cunningham Tunnel, about 2.9 miles long; Ivanhoe Creek Crossing, about 450 ft long, and Nast Diversion. Alternate schedules for tunneling will allow construction of either a horseshoe-shaped section with an unlined "A" line diameter of 8 ft 9 in., or a circular section with "A" line diameter of 8 ft 7 in. The tunnel will be nominally unlined with shotcrete specified for support. Steel rib supports and formed concrete lining will be specified for certain reaches. The tunnel will be driven from the outlet portal. Access to the outlet portal will be over the Nast Tunnel access road that will be constructed under Specifications No. DC-6803. The Ivanhoe Creek Crossing will extend from the Cunningham Tunnel outlet portal to the inlet portal of Nast Tunnel, and will be a 7-ft 3-in by 7-ft rectangular concrete conduit constructed on embankment. A reinforced concrete access structure will be required at the outlet portal of Cunningham Tunnel. Nast Diversion will consist of Nast Diversion Dam on Ivanhoe Creek and about 300 ft of rectangular concrete conduit connecting to the Ivanhoe Crossing. About 34 miles east of Basalt.
MRBP, Minn	Additions to the Morris Substation (Stage 03) will consist of constructing concrete foundations; furnishing and erecting steel structures; furnishing and installing one 230-kv and one 115-kv power circuit breakers, and associated electrical equipment. About 4 miles west of Morris.
MRBP, ND	Constructing about 13 miles of the single-circuit, 3-phase Garrison-Snake Creek 115-kv Transmission Line which will consist of furnishing and erecting wood-pole structures; constructing concrete foundations for steel towers; furnishing and erecting 12 steel transmission line towers; furnishing and stringing three 954-MCM, ACSR conductors and 2 steel strand overhead ground wires. Extending from the siwtchyard at Garrison Dam to the Snake Creek Embankment, North Dakota.
Do	Additions to the Watertown Substation (Stages 12 and 13) will consist of constructing concrete foundations, cable trenches, duct banks, and manholes; furnishing and erecting steel structures; furnishing and installing two 230-kv power circuit breakers, one 15-kv unit substation, and associated electrical equipment. About 3 miles east of Watertown.
MRBP, SD	Constructing a 60- by 120-ft O&M building, including area grading and drainage of the 2.75-acre site. The building will be a combination of reinforced concrete and masonry construction. A precast, prestressed, double-tee roof and a loft floor of precast hollow-core decking are to be included. The foundation will be of grade beam-caisson type. Huron.
Navajo Indian Irrigation, New Mex.	Constructing Cutter Dam, a zoned earthfill structure about 90 ft high and 950 ft long, and the following appurtenant features: a 20-ft-wide uncontrolled chute spillway in the left abutment; a 27- to 36-in. steel-lined river outlet conduit and gate structure; a 24-ft-wide canal outlet works with top seal radial gate; a cable-suspended fishscreen across the inlet channel to the canal outlet; and 0.25 mile of access road. In Cutter Canyon, about 34 miles southeast of Farmington
Do	Constructing the 15,550-ft-long Tunnel 3 and the 3,423-ft-long Tunnel 3A, which are to be either 18-ft-diameter circular of 17.5-ft-diameter horseshoe shaped; and constructing 3,270 ft of concrete-lined canal with a 23-ft bottom width and 11.8-ft water depth. From 30 to 35 miles southeast of Farmington.

*Subject to change.

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

Street address
Name

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS
RETURN AFTER 5 DAYS

POSTAGE AND FE
U.S. GOVERNMENT PRI

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

Enclosed find $............. (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

......	MINNESOTA. I 1.91:M 66	60¢	......	MARYLAND. I 1.91:M 36	75
......	ALASKA. I 1.91:Al 15	65¢	......	WEST VIRGINIA. I 1.91:W 52 V	45
......	TEXAS. I 1.91:T 31	45¢	......	OHIO. I 1.91:Oh 3	45
......	ARIZONA. I 1.91:Ar 41	45¢	......	WASHINGTON. I 1.91:W 27	50
......	MASSACHUSETTS. I 1.91:M 38	45¢	......	NEW MEXICO. I 1.91:N 42 M	50
......	COLORADO. I 1.91:C 71	50¢	......	IDAHO. I 1.91:Id 1	50
......	OREGON. I 1.91:Or 3	50¢	......	UTAH. I 1.91:Ut 1	45
......	NEVADA. I 1.91:N 41	45¢	......	WYOMING. I 1.91:W 99	65
......	CALIFORNIA. I 1.91:C 12	60¢	......	SOUTH DAKOTA. I 1.91:So 8 D	65
......	MONTANA. I 1.91:M 76	50¢	......	INDIANA. I 1.91:In 2	45
......	PENNSYLVANIA. I 1.91:P 38	65¢	......	NORTH DAKOTA. I 1.91:N 81 D	60

Name ....

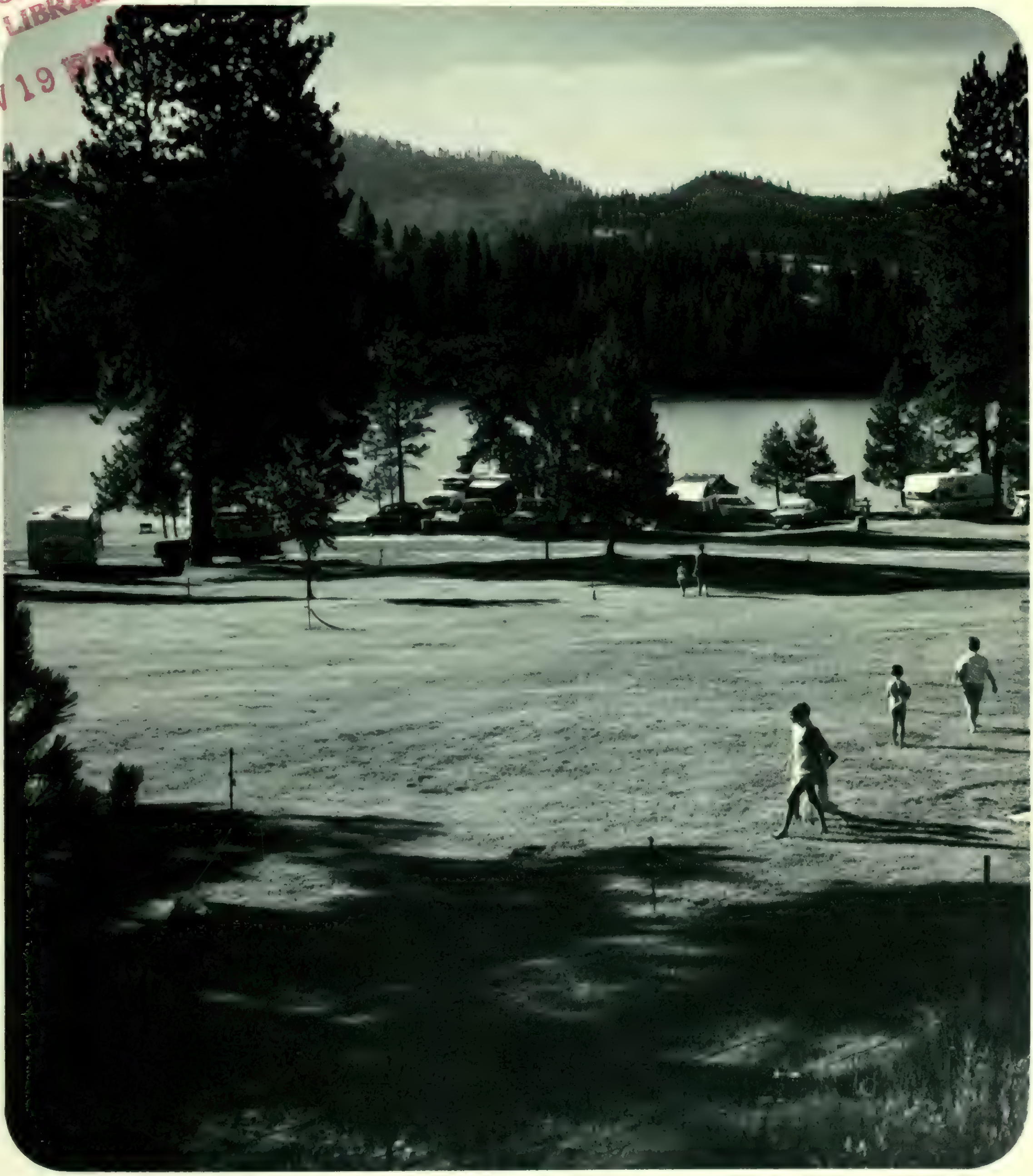
Street address ....

FOR USE OF SUPT. DOCS.

November 19

RECLAMATION era

A WATER REVIEW QUARTERL



Nov. 1970 • Vol. 56, No. 4

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER. Visitors are in danger of getting hooked on such no-special-hurry-to-leave spots as this at San Poil Bay Camp near Grand Coulee Dam, Wash. (*Photo by J. D. Roderick*)

United States Department of the Interior
Walter J. Hickel, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAG

Making the Miracle

Can Man continue to achieve a high quality of li on earth and, at the same time, maintain the necessa physical qualities of the earth and biosphere which Natu has provided for his use? This is the big question whi we must answer positively . . . or we perish.

Just as Man's survival has required creative use the natural resources, his survival now requires a thorou assessment of the depletion of and damages to the sources—and determined maintenance and repair eliminate further environmental decay. That is the shoc ing place we stand today.

The Council on Environmental Quality has fou in its first annual report that all of our principal resourc require major attention.

There is severe air pollution in some areas whi must be cleaned up. Land use and control influences a very complex, but there is urgent need to begin shaping comprehensive national land zoning policy. Faced wi dwindling supplies of minerals, alternative courses of tion are to seek substitutes, new supplies, and redu dependence on the technologies using them. Forests a being exposed to new and urgent demands which requ a necessity for a higher degree of planning.

Utilities are producing 75 percent more electrici nationally than they were only 10 years ago. But pow shortages are increasing and the crisis is worsening as t country grows. This essential element of living needs maj attention, but developments must be such that as not further deteriorate or poison our biosphere. Fish, bird a animal life and other phases of Nature's ecology al require concerned efforts.

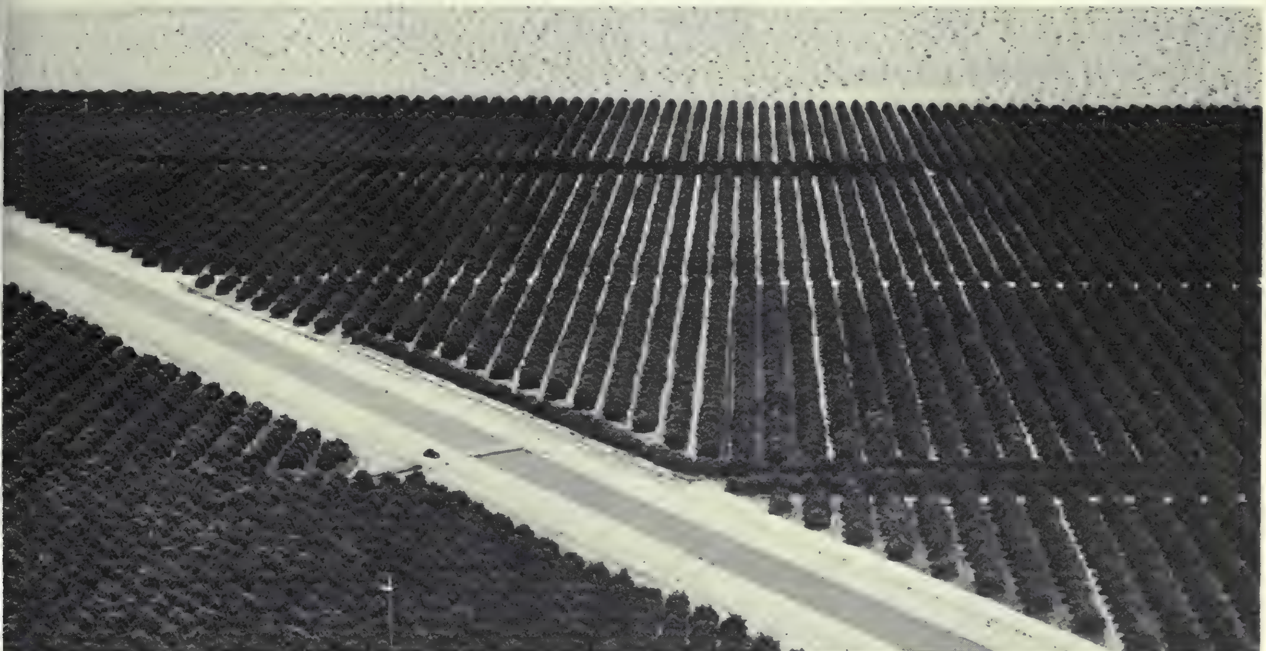
Water is the workhorse of the environment. Becau it is being polluted or is in short supply, various water u and re-use technologies must be continued, improved, undertaken as each case dictates. In addition to continui its beneficial water development efforts, the Bureau Reclamation recently began the Westwide Water Surve which is a program to learn Man's needs in relation water. This will be a remarkable aid to future water pla ning and use.

The complexities of the environmental challeng are tremendous and appear impossible to many people w are dooming the world to destruction in a matter decades. I refuse to accept such defeatism. I believe the destiny of Man and in his ability to enhance and mai tain a quality environment if he will put his intelligen and skills to it. The greatness of Man is his constant i provement and struggle upward. That is the Miracle America—and the reason we will succeed in the battle f the environment.

ELLIS L. ARMSTRONG
Commissioner of Reclamati

Our Nation's Manmade Environmental Bonanza!

Because of Irrigation—



The miracle of using water versus the contrast of practically no water is on the desert at Yuma, Ariz. This photo shows part of the 25,000 acres of citrus production resulting from dependable irrigation in the area.

In another Reclamation area, Bear Lake in northern Utah, delicious raspberries would not otherwise be feasible, as they are on the irrigated Hildford Farm, the largest such farm (31 acres) in the State.

From Reclamation water facilities, 573,000 persons working on full or part-time farms in arid or semi-arid areas last year received irrigation water which is reliably available year after year.

Because of Reservoirs—

Hundred of persons throng to Bureau of Reclamation reservoirs on weekends throughout the summer months, and year-around in some areas. Top photo is Carter Lake near Loveland, Colo.; bottom photo is in Wyoming.

Last year 11,400 miles of shoreline at reservoirs were available for public recreation. There were 535 developed campgrounds available, over 8,000 miles of interior access roads, over 17,000 picnic tables, 176 swimming beaches, and 10,600 boat docks.

Reclamation investment in recreation facilities is $18.2 million.

Because of Manmade Refuges—

This is one of the excellent manmade bird re-uges in northern Colorado. The elk in the other hoto are a few of the approximately 2,000 which se Coyote Basin winter range on a game manage-ent area near Gibson Dam, Mont.

There are 570,000 acres of game refuge areas n Reclamation lands.

Because of Regulated Rivers—

A 28-foot pontoon raft nearly disappears as it plunges into the rapids at the beginning of Hells Halfmile on Green River in Colo. The flows are regulated by Flaming Gorge Dam upstream, and considerable exciting boating and fishing take place. Similar memorable experiences are available in many other river areas downstream from Reclamation dams.

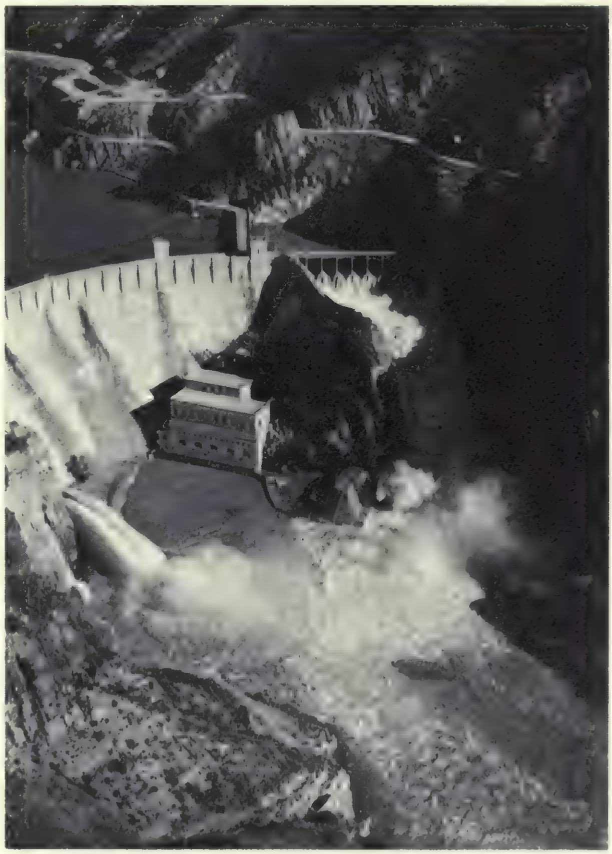
Because of Flood Storage—

Flood control benefits of $674 million in property protection value have been totaled since 1950 by Reclamation dams. Lives saved from flood control are numerous and of inestimably high value. The accompanying photograph of Owyhee Dam in Oregon graphically depicts the way a dam controls river flow, at flood heights or not, although there is greater flood protection required of some other Reclamation dams.

Because of City Pipelines—

Clean water piped into homes is an important part of a clean environment, as can be seen on the clean children's faces in the bathing photograph. The other photograph is a water purification plant serving the needs of Altus, Okla., residents. Municipal and industrial water deliveries totaling 585.8 billion gallons provided about 60 percent of the total requirements of 14 million people in the West served by Reclamation last year.

Because of Pollutionless Electricity—

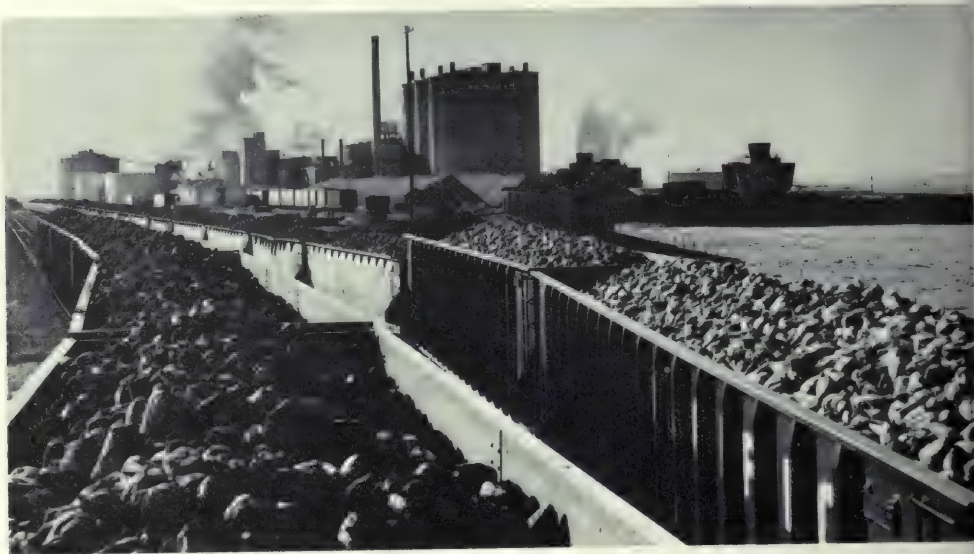


Hydroelectric powerplants do not cause pollution of the air or water. Theodore Roosevelt Dam and Powerplant, one of the first such Reclamation projects is shown here.

Many people are moving to rural areas because the environment is quiet, scenic and nonpolluted. And they may enjoy the comfort of a dependable power and water supply.

Through its 49 powerplants, Reclamation power is available by interconnected networks for seasonal uses over the entire West and during emergencies, by displacement from coast-to-coast across the United States.

Because of Reliable Productivity—



The sugar beet factory showing abundant agricultural and industrial productivity is at Moses Lake on the Columbia Basin water project in Washington. The irrigation function of the multipurpose water project is what makes the production meaningful and reliable for that region and the Nation.

Because of Cloud-Seeding Science—

This research specialist is using a time-lapse motion picture camera in studying cloud systems as part of Reclamation's nationwide Project Skywater. It is a research program to augment precipitation in needful areas through weather modification. Increased emphasis is being put on this program to provide techniques of precipitation modification in harmony with the environment, and create operable precipitation management systems.

Because of Paid Manpower—

The accompanying photographs are examples of how the construction of water resources projects provide work and salary benefits for heads of families. The tunnel construction photo is on the Navajo Indian Irrigation Project, N. Mex., and the canal building shot is in the Central Valley Project, Calif.

During a recent 18-month period Reclamation's manpower utilization on contracts for construction was about 10,000 man-years of on-site work. Off-site manpower use in providing materials and equipment was about the same amount as the on-site.

Because of Security Against Fire—

Many communities receive a dependable water supply to safeguard against such emergencies as fire, from Reclamation's multipurpose water systems. The town of Hays, Kans., is justifiably proud of their new snorkel fire engine being demonstrated here.

Because of Minority Opportunities—

Seated at the typewriter is Priscilla M. Arthur, a Navajo girl who took a job to earn money during summer months at Reclamation's Navajo Indian Irrigation Project office. For the regular school year she enrolls at the University of New Mexico.

To establish irrigation practices among, and to help enhance economic conditions of the Navajo people at the Agricultural Experiment Station on the above named project, is Lee Barber, Navajo farm assistant. The Navajo highscaler working on the side of a cliff at the site of a new dam is George Charlie.

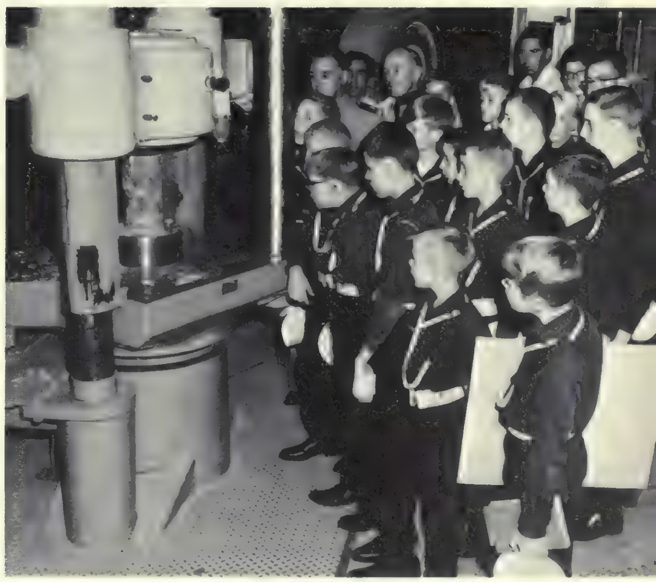
Because of Overcoming Failure—

Learning a man's job—to successfully operate a large tractor at a Reclamation Job Corps Center—is Job Corpsman Rudy Abeyta of Lakewood, Colo. His instructor is Floyd Johnston. The young men also develop their first skills at many other kinds of work, such as finishing concrete, as demonstrated by Corpsman Larry Thomas, at left in the other photo.

Because of Informing Future Leaders—

This is a select group of Navy Sea Cadets at one stop on an informative tour of Reclamation's Research Laboratory at Denver, Colo. School study classes are held at actual, full-sized water projects.

Some of today's youth will be interested in and use the scientific technology which applies to successfully developing vital water supplies for environmental betterment. And today's youth will be tomorrow's citizens and leaders. # # #



Memoirs of a mountain man

OLIE, OPERATOR OF DAMS

by DONNA BRADFORD
Phoenix, Ariz.

A light snow was beginning to fall as Lionel Johnson, a small boy of seven, climbed into the covered wagon with his family.

Wagon wheels crunched against the frozen ground as the horses pulled away from their home in Blue Water, N. Mex., in the middle of winter, 1912.

Lionel poked his head out from the wagon flaps and watched as the covered wagon drove over rivers that were frozen solid with ice. The Johnson family was on its way to a new home in Tucson, Ariz.

Lionel sat in the corner of the wagon and reflected on the traveling his family had done. He had been born in Old Mexico, at a time when Pancho Villa was on the rampage. After 6 years in Mexico, the Johnsons moved to Blue Water for a year, and now they were making a 3-week journey to Tucson.

The young boy's travels did not end with the trip to Tucson. After a year there, the family moved to Mesa, then back to Old Mexico where he attended the Juarez State Academy and again to the Phoenix area. While at the Academy, Lionel met Anna Carlton whom he married.

When has was 20, Lionel and Anna went to Bisbee where he worked in the mines. It was in Bisbee that Lionel was given the name of Olie by his fellow-workers. That nickname has stayed with him for over 40 years.

Olie Retires

Olie didn't stay in Bisbee very long. He returned to Phoenix and went to work for the Salt River Project in 1928. Last month, Olie retired after 42 years with the SRP.

He worked in several capacities for the SRP including troubleshooting, reading meters, and serving as a power operator. He worked at Roosevelt, Horse Messa and Stewart Mountain dams (which have had construction additions by the Bureau of Reclamation) taking his family with him as he went.

Olie and Anna had three children. The eldest was a son, Kenneth, and then twins, Clyde and Clydene. While they were living at the dams, the children attended accommodation schools, but most of their education took place in Glendale where Olie had built a house on West Myrtle Street.

The family lived in Glendale for several years while Olie worked as a troubleshooter. During this time, tragedy crept into their lives when doctors discovered that Anna was suffering from a tumor in the spinal cord. She died in the spring of 1952 following a long illness.

Olie continued to work and care for his family with the help of family and friends. In December of 1952, he married Audrey who had been a friend to the family for 10 years. They lived in Glendale 4 years before moving to Stewart Mountain Dam where Olie served as chief operator.

Olie and Audrey settled into their home there where they would remain 14 years. The white house, set at the bottom of high cliffs, was sur-

rounded with a lust green lawn bordered with bright flowers and a vegetable garden.

Chief Operator

As chief operator of the dam, Olie was overseer of the camp, the plant and dam at Sahuaro Lake. Five men, who had also moved their families to the small community at the dam, reported to Johnson.

Isolated from many of the conveniences found in larger communities, the families at the dam learned to rely on one another. Olie's familiar smile and willingness to help made him more than chief power operator at the dam. While he lived there, he worked as doctor-veterinarian-handyman and general good neighbor.

Faced with dilemmas, Olie often took the lead to help. "About the most drastic thing that ever occurred while I lived at Stewart Mountain," explained Johnson, "happened a few years ago when two young boys left a group they were hiking with to scale the cliffs behind my house. They had climbed about 75 or 80 feet up the steep bluffs when they fell. One boy was killed, while the other one was badly injured," he continued.

"It was late in the evening before they were reported missing, and we (the rescue party) didn't find them until around 2 a.m. Darkness and the rugged terrain were a hindrance to us, but we made a stretcher out of boards and carried the injured boy down the side of the mountain."

Audrey recalled the floods in 1965 when a warm rain melted the deep snow on the watershed, causing excessive runoff into the lakes. "It was scary to see what had been dry desert the day before turn into expanses of turbulent water. Olie didn't come home for 3 days, he was so busy at the dam."

"During that time," continued Olie, "we had to open the spillway gates which hadn't been opened for flood control since 1941. A boy who was at the lake boating saw the water coming out of the gate, and thought there was a hole in the dam.

"He rushed back to where his father was and told him the dam was breaking, and it wasn't too long before most of the people in the Phoenix area were hearing that the dam had broken.

"Of course, there was nothing wrong with the dam at all," he concluded.

Interesting Stories

Residing 14 years at the dam, Olie lived what he describes as a very uneventful life. But his stories included several incidents of humor and warmth.

"Almost everyday," he recalled, "we would have someone come by for help who was either stuck in the sand, had a flat tire or needed an inner tube patched."

He was particularly helpful to his neighbors. One of his hobbies included growing a fresh vegetable garden, and he shared his crops with the neighbors. He also changed light bulbs, trimmed trees, and repaired small appliances for them.

One woman, who needed shots frequently could not get into town every time she needed one. Olie had given shots before, so he volunteered to give them.

He also served as a veterinarian. His laughter filled the room as he explained one of his more unique treatments. "We had a chicken once who had a growth on her head. The chicken would have died if I'd let the growth continue, so I decided to operate.

"I didn't know how to anesthetize a chicken, so I grabbed a soda pop bottle and hit her over the head with it. While the chicken was 'out' I removed the growth, and she lived for quite awhile, a very happy chicken."

As chief power operator, Olie conducted many visiting groups through the dam. "I know in 1969 alone, we had 45 tours with nearly 2,000 people visiting Stewart Mountain Dam."

Moved to Lakeside

Olie and Audrey have moved to Lakeside, Ariz., where they are putting the finishing touches on a house they started building 10 years ago. He is renting the house in Glendale.

As Olie turned in his keys to his office and made his final tour of the dam as chief operator, he added, "I've been working for a long time, and I'm ready to retire.

"Now that I've retired," he continued, "we're just going to go to Lakeside and play it by ear. I've thought about opening a small appliance repair shop there, or we might just travel around the country for awhile. I haven't been back to Old Mexico since I attended the Academy there in 1923, and I'd like to go back."

Just in case they make it, Audrey has been taking Spanish classes at SRP's Pera Club. She's helping Olie brush up on his Spanish by practicing her lessons at home. They want to get a travel-trailer in which to make their journeys . . . a far cry from a covered wagon. # # #

(*Reprinted by courtesy of the Editor of the* Current News *of the Salt River Project.*

Mr. Catfish, gentleman farmer. Drawing by Richard Groesbeck.

New farm crop for Imperial Valley

WHISKER FISH FARM

by EUGENE E. HERTZOG, Head Regional Photographer, Boulder City, Nev.

NONEXISTENT 10 years ago, catfish farming harvested nearly 30 million pounds of tasty fish last year.

California's largest producer of this new agricultural product is Mesquite Lake Catfish Farm, which uses Colorado River water through the All-American Canal built by the Bureau of Reclamation. The 320-acre farm expects to market 600,000 pounds of this finny product yearly.

The farm of whiskered fish is owned by Imperial Valley Enterprises, Inc., a 17-stockholder corporation which has invested nearly a quarter of a million dollars in the operation. It is located in Imperial Valley near the town of Brawley in southern California. "Lowest Down Commercial Catfish Farm in the World" is the advertisement referring to the farm's elevation of 119 feet below sea level.

The All-American Canal, one of the world's largest, transports Colorado River water from the diversion works of Reclamation's Imperial Dam. The canal is 80 miles long, and irrigates about 440,000 acres of otherwise desert farmland.

The catfish farm started in November 1968 with 90,000 four- to five-inch fingerlings transported from Mississippi. Brood fish, which are kept for reproduction, averaging 16 inches and weighing 3 to 5 pounds, have since produced over 3 million fingerlings.

Astronauts Spot Farm

Although the desert existence of this farm is unusual, it also is strange that it shows as bright red

Average brood catfish is 16 inches long and weighs 5 pounds.

Robert Dailey, farm supervisor hoists a large catch while Ben Lane, foreman, in pond completes loading with hand net.

Jena Lane and Lin Dailey team up to transfer fish to vats.

By the barrel, 20 percent of total, are sold retail to individuals.

on special space flight film. Apollo astronauts far out in space pointed their camera in that direction, and because the water showed as red on the special film, they at first thought they had found a new desert oasis. NASA representatives who investigated on the ground, however, found the 320-acre farm of catfish.

Also travelers, seeing the desert industries for the first time, hardly expect to see the catfish operation.

Robert Dailey, Farm Supervisor, explained that Imperial Valley is the most desirable location in the Nation for this type of operation. The area was selected because of its:

1. Availability of a dependable supply of quality, low-cost water, with a high oxygen content, which is critical for catfish production.
2. Low-cost land and impervious soil conditions.
3. Ideal air temperature and maximum sunshine, helping to maintain a good oxygen level in the ponds.
4. Close to a large market area, that of the Southern California communities.

Even though they are bewhiskered, these farm-cultured fish are flavorful. They are fed for it. The feed contains milo maze, soybean meal, fish meal, meat meal, fat, salt, vitamins, and antibiotics. One and one-half pounds of feed result in one pound of gain on the fish.

There are more than 1,000 catfish species in the world; 30 in North America. For catfish farming, three are normally used—channel, blue, and white.

Mesquite Lake uses channel catfish exclusively, as they are considered best eating among food fish and have an easy-to-remove bone structure.

14 Ponds

One-half million gallons of Colorado River water are used to fill 14 ponds ranging in size from 2½ to 35 acres to a depth of 5 feet.

During pond construction, 425,000 cubic yards of soil were removed. Marginal land with high salinity, not suitable for most agriculture, is ideal for construction of ponds because of its ability to hold water.

Each pond can be independently filtered or isolated from the system as necessary.

The ponds are checked daily for oxygen content and water temperature. Automatic feeders are installed in the production ponds with additional feed propelled into each pond twice a day.

According to Supervisor Dailey, local retail sales of fish accounts for about 20 percent of production, considerably more than was first expected. Some advertising is done, but there is word-of-mouth enthusiasm for the tasty fish, and most of the business is repeat customers.

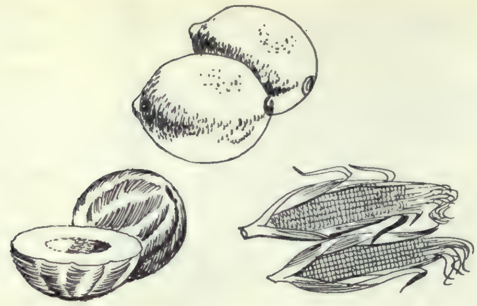
At the time of sale the average size fish is one and one-half pounds. Eight hundred to 1,200 pounds of fish are sold to individual customers on a weekly average of 60 cents per pound.

The greatest percentage of sales are to retail outlets in the Los Angeles area through the farm's Wilmington, Calif., broker, where the weekly market is from 3,000 to 8,000 pounds. Other outlets include stocking fish for fee fishing in lakes and recreational areas; also fingerlings and broodstock.

Although catfish farming is small today, it is growing and the future looks good in the valley area. As the number of farms increases, problems in marketing will diminish. A local processing plant is in future plans for the area. This will eliminate long-haul risks to market by the individual farmer.

Although there are many risks, whisker fish farming can be more profitable than most crops. By the pound, catfish bring a better price than beef, pork, or poultry. By the acre they bring more net profit than rice, cotton, or soybeans.# # #

In Australia, Israel and U.S.



STARTING WITH TRICKLE IRRIGATION

by E. DALE DE REMER
Phoenix, Ariz.

IT is timely this year that so many sprinkler irrigation specialists are given opportunity to present knowledge of their specialty to the rest of us and relate to the solution of pollution problems. My address is one of them and has to do with trickle irrigation through use of the combination pivot move and automated solid-set sprinkler systems.

Principal advantage of the combination of these two systems is that the cost per acre is low. But we also are talking about ground water pollution and wasted water. These are common problems of the American farmer.

When one sees 10 to 20 acre-feet of water frequently used to irrigate one acre of an orchard, it shows that many irrigators waste this valuable resource; and after the water is leached through the soil it may be a source of ground pollution.

My brief report is to show that several workers, independent of each other, are reporting phenomenal water savings and sizable yield increases.

Up to now, no one has gotten particularly excited about trickle irrigation because it hasn't been commercially available in this country. However, it is becoming available now.

Israel has worked with trickle irrigation and Australia, also, has done some significant work with it.

Trickle irrigation is basically a solid set system which uses very low rates of application so that a smaller distribution system can be used, and so that water flowing into the soil will allow the soil to always be in the unsaturated state, but near field capacity.

Israel has been using trickle irrigation effectively for about 8 years. Thousands of acres in that country are now being irrigated this way.

Also in Australia

Australia has also been doing considerable research on trickle irrigation, and has produced a publication entitled, "Trickle Irrigation" which I recommend as a starting point for anyone interested in learning more about the subject.

Studies in Israel show yield increases of 50 to 100 percent with trickle irrigation, as compared with sprinkler and furrow irrigation for tomatoes, cucumbers, melons, peppers, and sweet corn. It shows plant growth rates nearly doubled under trickle irrigation on sweet corn and pepper plants over sprinkler irrigation.

A study comparing leaf chloride content with a high salt water source shows melons, beans, peppers, and grapes had very significantly lower leaf chloride under trickle irrigation than with sprinkler and furrow methods.

Several good studies with saline water have been completed. One such study, done on tomatoes, uses good and poor water. With the trickle system, there was no decrease in yield with the salty water. With sprinklers there was a 5 ton decrease in yield due to the salty water.

Lack of Research

Research in this country is lacking, mostly because researchers have concerned themselves with perfecting the reliability of the distribution system

Grapes are one of the crops on which trickle irrigation is used.

before proceeding with agronomic testing. Until recently, systems with any degree of reliability did not exist. Now there is at least one system that is sufficiently reliable for commercial use.

Such a system has been in use for 1 year on a lemon orchard at Yuma, Ariz. The same system has been used in orchard plantings, melons and strawberries on research stations in California. Now a larger system is being installed for use on melons at the Imperial Valley field station at Brawley. The system is being installed commercially on citrus and deciduous fruit trees and grapes in Arizona.

Before discussing the 1-year study at Yuma, Ariz., let's look at the problems of water losses.

Most irrigation methods, particularly conventional methods, leach some water through the root zone because of inefficient system designs, and overly long water applications.

Leaching is required to control salt buildup, but sometimes the operator simply applies more water than the soil can hold because for him there is no way to really tell how much water to apply, nor how often. Nor is there an accurate way to measure the amount of water getting to the soil.

Four Ways

There are four ways water is lost through evaporation. The first way is from transpiration, or evaporation from plants. The second is from soil surface evaporation, which, from desert soils with a surface temperature of 160 degrees, far exceeds the third source, free water surface evaporation.

Fourth, evaporation from water distribution systems is usually greatest especially from systems which throw water into the air. However, these systems cool effectively and have the desired humidity modification which is important to some crops on the desert.

A marked reduction in evaporation losses occurs with the trickle system because only a small soil surface area remains wet. This system results in about 1/1000 the area of wetted soil surface as compared with methods of surface irrigation.

Although the trickle system can be used for leaching as needed, studies show that saline water can be used effectively.

Water savings by trickle irrigation can be particularly significant in young orchards. If a water distribution system has the capability of wetting only the small trees root zone, which may be only 3/100ths of the total area allotted for the tree when it is mature, then the system will save a very significant amount of water. I must add, however, that the system must be capable of supplying the trees' needs when it is larger, so the system must be well designed.

On Lemon Grove

Let's look at the results of 1 year on the 3-year-old lemon grove of grower Elliott Waits of Yuma, Ariz. Mr. Waits had 40 acres of lemons—all treated alike, so he installed a trickle system on 10 acres and kept records comparing the 10 acres of trickle with the remaining 30 acres under furrow irrigation. The trees are well filled out. The light colored leaves are not chlorotic—they are new growth. You can see the lines going under the trees. Each tree has two emitters, each of which will apply about 10 gallons in 12 hours.

Here are the results (see table). Water use was 1/9th, irrigation labor cost was 1/16th. Cultivation was reduced to 40 percent of normal; fertilizer use was 20 percent, and yield was more than doubled.

In addition, there was about 30 percent more new fruitwood growth on the trickle irrigated trees, which means that next year's yield differences should be equally spectacular.

Gentlemen, it appears that we have a new tool for irrigation that will have some applications in

r industry. The trickle method will not only lp the grower who is operating with scarce, exnsive or saline water, but will help us conserve r number one natural resource, water, and also ssibly aid in decreasing ground water pollution.

# # #

ppreciation for reprint permission of this eech goes to Dr. De Remer, and the Sprinkler rigation Association, Washington, D.C., who inted it with other proceedings of the 1970 conrence of the Association. Dr. De Remer is agriltural consultant with Business Dynamics orp.)

A 1-year study of irrigation on 40 acres of lemons. Yuma, Ariz.—1969

Comparing	Surface irrigation (furrow)	Trickle irrigation (Salco system)
Water use (acre ft./acre)	9	1
Irrigation labor (cost/acre)	$4. 12	$0. 25
Cultivations	5	2
Fertilizer:		
Pounds N/acre	242. 5	64. 7
Cost/acre	$32. 53	$13. 48
Yield pounds of lemons/acre	245	584

NOTE.—Fruit quality was not compared due to frost damage on surface-irrigated fruit. Frost damage did not affect yield.

Bureau of Reclamation
Water Headquarters Offices

MMISSIONER'S OFFICE:
St. between 18th & 19th Sts. NW
shington, D.C. 20240

IEF ENGINEER'S OFFICE:
lg. 67, Denver Federal Center
nver, Colo. 80225

AHO (Except SE tip)
SHINGTON
NTANA (NW corner)
EGON (Except Southern wedge)
egion 1)
deral Bldg.,
W. Fort St.,
ise, Idaho 83707

LIFORNIA (Northern & Central)
VADA (Northern & Central)
EGON (Southern wedge)
egion 2)
deral Bldg.,
0 Cottage Way,
cramento, Calif., 95825

VADA (Southern)
LIFORNIA (Southern)
IZONA (Except NE tip)
AH (SW tip)
egion 3)
. Box 427
ulder City, Nev. 89005

AH (Except SW tip)
LORADO (Western)
W MEXICO (NW tip)
YOMING (SW tip)

IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
Herring Plaza, 317 East Third
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

WATER Quiz

[1] This forceful release of falling water through ← "needle valves" at the bottom of Friant Dam, Calif., has three benefits. Which of the three benefits is most important?

a. to give sightseers a dramatic show
b. to protect the dam's foundation from the rushing flows
c. to benefit the water with aeration

[2] Reclamation makes extensive plans and investigations of its potential water projects. After the plans have been reviewed by, and comments received from all States and Federal agencies concerned, how are the review comments utilized?

[3] What is the first thing a non-Federal water organization should do in the 17 Western States to obtain Federal monies for building or rehabilitating a small reclamation water project?

[4] What is the maximum loan obtainable from the Bureau for a small reclamation water project, noted in Question 3 above?

[5] This farmer is inspecting his irrigated wheat ← field located near Sacramento, Calif. Perhaps you can tell by the amount of wheat growth, which of the 1968 dates below is right for the time this photograph was taken?

a. June 4
b. July 10
c. August 4

ANSWERS:

(1. (b) To protect the dam's foundation from the rushing flows; 2. They are sent with the plans to the President and then to Congress for considering authorizing legislation to construct the project; 3. Contact the Regional Director of the Reclamation region affecting you on page 17; 4. $6.5 million.; 5. (a) June 4)

ts growth and
huge potential

TEXAS—125 Years Young

y JOHN T. SIMPSON,
Chief, Program and Reports Div., Austin

TEXAS is . . . vast . . . proud . . . and rich. Texas is a way of life. That's how it's been for ver 125 years, and that's how it is today.

Next month marks the 125th anniversary of 'exas statehood. The event was in December 1845. After 9 years as an independent nation, Texas had ccepted a proposal by the United States Congress or annexation, which was ratified in 1845 when Congress approved the new Texas constitution.

This event immediately precipitated trouble—he war with Mexico, which was terminated in 3 ears by the Treaty of Guadalupe Hidalgo. The Rio Grande was established as the southern boundary of Texas and the United States.

However, Texas seceded from the Union and oined the Confederacy early in 1861. Following he Civil War and Reconstruction in 1870, Texas vas readmitted to the Union after ratifying he 13th, 14th, and 15th amendments to the Constitution.

Figuring in the growth of El Paso, Tex., now over 315,000 persons, are the 50 years of water service into the city and for irrigated agriculture from Reclamation's Rio Grande water project.

Citrus orchard gets attention at the Texas A&I Experiment Farm.

Settlement proceeded rapidly during the rest of the 19th century, with the population in Texas increasing from less than 1 million people in 1870 to about 3 million by 1900. This expansion resulted from a transformation of the State's economy. The State had depended upon export of millions of cattle during the famous trail drives of the 1870's and 1880's, and crop production for local consumption. And the change was to a balance based on export of both crops and livestock.

Three factors dating from the mid-1870's were primarily responsible for this change. The first was elimination of major Indian hostilities. Second was the introduction of and widespread use of barbed wire. And third was rapid expansion of railroad construction which resulted in markets for additional agricultural production.

High In Production

Today, Texas leads the Nation in production of cotton, grain sorghum, and rice and in the number of cattle and other livestock. It ranks high among the States in the value of crops, harvested crop acreage, and the combined value of crops and livestock. Texas has more farms and more farmed acres than any other State.

Since 1900, discovery and development of enormous reserves of petroleum, natural gas, and sulphur have made Texas the leading producer of minerals among the States. Until World War II, however, the mineral and agricultural raw materials were largely processed into finished products elsewhere in the Nation, and petroleum refining was the State's only major manufacturing industry.

A combination of favorable circumstances has sparked a rapid industrial expansion since 1940 which is still in progress. These include large mineral reserves, ready accessibility by sea to foreign sources of raw materials, cheap water transportation, adequate water supplies to meet the large requirements of industries, and availability of cheap electric power based on natural gas as a fuel. Also, the technology of processing minerals into a wide variety of new products advanced swiftly as did the expanding national market for those finished products.

As a result, employment in manufacturing increased from 164,000 in 1939, to 708,000 in 1968; and value added by manufacturing in Texas grew from $449 million in 1939 to $9.7 billion in 1966.

11 Million Population

The Texas population increased from 6.4 million in 1940 to about 11 million now. In a typical urban-rural shift, 45 percent of the people lived in the cities in 1940; by 1960 this figure had grown to 75 percent.

Irrigation was introduced into Texas by the Spanish but was limited almost entirely to small scattered developments by individuals until after 1900. Organized irrigation development on a substantial scale began in the El Paso area, in the Lower Rio Grande Valley, and in rice-growing areas along the Gulf Coast prior to World War I.

By 1940, about 1 million acres were irrigated. Approximately three-quarters of this area was supplied from streamflow and the balance from ground water. Surface-water irrigation stepped

Texas beef cattle grazing in an irrigated barley pasture.

up to 1.3 million acres in 1949 and has held steady at that level since then. However, ground-water irrigation has accelerated raising total Texas irrigation to 6.7 million acres in 1958, and to 7.7 million acres in 1964.

Most of the irrigation growth occurred on the Texas High Plains, where 5.1 million acres were irrigated with ground water in 1964. Making a vital contribution to the Texas economy, irrigated areas account for more than one-half of the total value of crops harvested in an average year and about two-thirds of that value in a severe drought year.

Reclamation Starts

Reclamation's activities in Texas began soon after passage of the Reclamation Act with the Rio Grande project in south-central New Mexico and in the El Paso area of extreme west Texas. Investigations began in 1903 and construction in 1906. The project consists of Elephant Butte and Caballo Reservoirs, hydroelectric powerplant, and irrigation distribution and drainge facilities. The project supplies water for 178,000 acres of land, of which 57 percent is in New Mexico and 43 percent in Texas.

Business activity associated with the agriculture of this irrigated project has made a major contribution to the economy of the El Paso area for more than 50 years. The project also provides part of El Paso's municipal and industrial water supply, and many people enjoy fishing and other forms of recreation at its reservoirs.

Marshall Ford Dam, which creates Lake Travis in the Austin area, was completed in 1942. It is the key structure in the Lower Colorado River Authority's six-reservoir system of water supply, flood control, and hydroelectric power facilities. Streamflow regulation afforded by Lake Travis and upstream Buchanan Dam provides an abundant water supply for municipal and industrial use in the Austin area. Other benefits are industrial water for Bay City, and for about 100,000 acres of rice irrigation.

Hydroelectric power production at Marshall Ford Dam and the other five dams in the Authority's system provides significant amounts of energy and standby peaking capacity for the central Texas area.

Flood Control Benefits

Operation of the flood-control pool of Lake Travis provides protection to the Austin and downstream areas against major flood damages. Estimates of damages prevented by storage of major flood inflows in only 3 years, 1952, 1954, and 1957, amounted to $17 million at prices then prevailing. Flood-control benefits through 1969 total more than $54 million.

The year 1947 marked the completion of the Balmorhea water project in the Pecos River Basin in west Texas. It provides a supplemental water supply to 10,600 acres of land in the vicinity of Balmorhea, thereby enhancing the area's agricultural production and economy.

The San Angelo project is a multipurpose development. It will provide a water supply for 10,000 acres of irrigation, part of the municipal and industrial water requirements for the city of San Angelo, protection against damage from floods on the South and Middle Concho Rivers, and substantial water-based recreation and fishing opportunities. Almost total lack of streamflow in the area tributary to Twin Buttes Reservoir since completion of the project in 1963 has prevented achievement of these benefits thus far.

Ideal boating for the landlocked sailer is at popular Lake Meredith behind Sanford Dam seen in the background.

Lettuce is one of the year-around crops in Texas because of irrigation. Reclamation water goes to 210,000 acres of the State.

Located on the High Plains, the flourishing Canadian River project was turned over to the Canadian River Municipal Water Authority for operation and maintenance July 1, 1968. Built by the Bureau of Reclamation, the project's principal storage structure is Sanford Dam located about 40 miles northeast of Amarillo and 9 miles west of Borger on the Canadian River (a tributary of the Arkansas River.)

Water Features

Distribution features of the Canadian River project include an aqueduct system comprised of 322 miles of pipeline, 10 pumping plants, three regulating reservoirs, and chlorination facilities. Water from the project's reservoir, Lake Meredith (created by Sanford Dam), is transported to 11 cities for municipal and industrial use.

These 11, Amarillo, Borger, Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Pampa, Plainview, Slaton, and Tahoka had depended on fast disappearing underground sources for their water. The supplemental water provided by the Canadian River project helps to conserve the dimishing ground-water resources. This project also provides protection against flood damage to downstream areas and offers an outstanding center for water-oriented recreation which attracts more than 1 million visitors yearly.

Under specific authorizing acts, Reclamation has rehabilitated the irrigation distribution and drainage systems of the La Feria Division (28,000 acres), and the Mercedes Division (68,000 acres) of the Lower Rio Grande Rehabilitation project, comprising the La Feria and Mercedes Districts, respectively.

With funds provided under the Small Reclamation Projects Program, similar rehabilitation has been completed by the Harlingen District (39,000 acres), and the Donna District (38,000 acres) and is in progress by the El Jardin District (16,000 acres).

Percha Diversion dam on the Rio Grande project.

Similar work is to be initiated in fiscal year 1971 by the Willacy District (69,000 acres), and the Santa Maria District (4,100 acres). By reducing distribution system losses and improving surface drainage, such rehabilitation contributes to the agricultural economy of the Lower Rio Grande Valley.

Now under construction, the Pecos River Basin Water Salvage project is designed to reduce nonbeneficial consumptive use of the streamflow and increase the water supply available for irrigation. The work includes clearing and controlling regrowth of nonbeneficial vegetation along the Pecos River in New Mexico and Texas.

Potential M & I Water

The Palmetto Bend project, construction of which is scheduled to start in fiscal year 1972, will provide a major municipal and industrial water supply to a section of the Texas Gulf Coast whose urban and industrial growth has been hampered by the lack of such a supply. The project will also provide significant fresh-water recreation and fishing opportunities, which are very limited in the central Gulf Coastal section of Texas.

Future water development by the Bureau of Reclamation in Texas is concentrated primarily in long-range planning of two interbasin and interstate projects. These are the West Texas and Eastern New Mexico Import project and the Texas Basins project. Both projects are major elements of the Texas Water Plan formulated by the Texas Water Development Board and published in November 1968. These projects are being systematically planned in cooperation with the Board and are directed toward implementation of the board's plan.

Planning for the great West Texas and Eastern New Mexico Import project is divided between the Bureau of Reclamation and the Mississippi River Commission, which is being assisted by the

Fort Worth District of the Corps of Engineers for the Commission's portion of effort in Texas. The project would include facilities for diversion of water from east Texas streams and the Mississippi River system and conveyance of that water to municipal, industrial, and irrigation users in west Texas and eastern New Mexico.

The general route of the conveyance facilities would be from some point on the Mississippi River system to some point near the Sabine River, up the divide near that river to the vicinity of Dallas, and then by canal along the divide forming the southern boundary of the Red River Basin to regulating reservoirs on the Texas High Plains.

Branches from this canal would serve municipal, industrial, and irrigation water users in the area between Fort Worth and the High Plains.

Other Potential

Other canals would extend from the regulating reservoirs to cities and irrigators on the High Plains in Texas and eastern New Mexico, in the Pecos River Basin, and in the El Paso area.

The Mississippi River Commission and the Corps of Engineers are responsible for the planning effort from the Mississippi River system to the vicinity of Dallas, with the Bureau of Reclamation being responsible for planning westward from the Dallas area.

The project water supply would be used to replace supplies now obtained from rapidly diminishing ground-water resources and to sustain the present development in west Texas and eastern New Mexico, if sufficient import water is available.

Mississippi Study

Potential requirements for import water of the above projects may be as much as 17 million acre-feet per year. The water supply that would be available to meet these requirements is currently not known, as the Mississippi River Commission is making studies to determine the extent to which Mississippi River system flows are surplus to future needs of lower Mississippi River Basin States.

To the extent that potential import water requirements can be supplied, the project would preserve the portion of the west Texas and eastern New Mexico economy now dependent on about 6 million acres of irrigated agriculture that will be discontinued in the foreseeable future as useable ground-water supplies are exhausted.

The project also would create substantial water-based recreation and fish and wildlife benefits.

The Texas Basins project would consist of an interbasin canal in the Gulf Coastal area of Texas. This canal would extend from the Sabine River to the Lower Rio Grande Valley, plus distribution and drainage facilities for 750,000 acres of new irrigation in south Texas. The project water supply would be obtained from surplus flows of east Texas streams and perhaps from the Mississippi River system. This supply would meet water requirements for the new irrigation, together with municipal and industrial water requirements in south Texas that cannot be met from inbasin sources.

Replace Grande Diversions

This transported water also would provide a supplemental supply to existing irrigation in the lower Rio Grande Valley, and an additional supply to the valley to replace diversions from the Rio Grande to the Winter Garden area of the Nueces River Basin. In addition, the project would supply water to Texas estuaries to replace reductions in fresh water inflow caused by nonproject developments, in order to improve sport and commercial fishing in these estuaries.

The project would provide excellent facilities for fresh water-based recreation in an area now largely lacking such opportunities and important fish and wildlife benefits.

Planning reports have been completed or are nearing completion on four other projects. They are: Columbus Bend project in the Colorado River Basin, the Cuero project in the Guadalupe River Basin, the Cibolo project in the San Antonio River Basin, and the Nueces River project in the Nueces River Basin, all of which are included in the Texas Water Plan.

These four projects would provide municipal and industrial water supplies for inbasin use and would create substantial recreation and fish and wildlife benefits. The Cibolo and Cuero projects also would provide flood control benefits.

These are big plans, but there is a lot of potential in a State the size of Texas. It is more than 800 miles from the north to the south borders. Or if one travels from the east to the west border, it is a 773-mile trip.

Texas is 125 years old, but it still is in its youth. It has experienced a colorful past—is enjoying a prosperous present—and is looking forward to a future filled with promise. # # #

443,000 visit
new "fun land" in 1969

Recreation Booms at San Luis Unit

This is fishing for catfish in comfort at the well stocked High Line Canal. In case a man is dozing when a fish takes his hook a tinkle of the bell at top of pole sounds a friendly alert.

WHAT was once an arid area with little or no recreation value, now abounds with people engaged in sports at the largest inland body of water between San Francisco and Los Angeles.

The attractive area became a large water mecca when the Bureau of Reclamation and the State of California combined their efforts in a landmark program to create the San Luis Unit water facility at Los Banos, 75 miles northwest of Fresno.

The unit is part of the Central Valley water project. It includes four dams and reservoirs, canals, pumping plants, and a pumping-generating plant. Ground was broken for the San Luis Dam on August 18, 1962.

The water project now makes possible year-round recreation for the local people and many others. During the month of February 1969 alone, visitors from all 50 States plus 59 foreign countries registered at San Luis' Romero Overlook, just off nearby Highway 152.

During 1969 about 443,000 persons visited the lake area, over five times as many as in 1968. This year over a million people are expected and even more are anticipated at the lakes when marinas and concessions are completed. The lakes are the only ones for recreation on the west side for the growing San Joaquin Valley population.

San Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir provide fishing, boating, waterskiing, camping, swimming, picnicking, duck hunting, hiking, and even frogging.

Many Trees

Eight thousand trees—eucalyptus, allepo pine, Arizona sypress, and live oak—have been planted to enhance appearance of the recreation areas, according to Clyde E. Strickler, Area Manager of the California Department of Parks and Recreation, which operates the recreation facilities.

There are two recreation areas at O'Neill Forebay—the San Luis Creek recreation area at the west side of the lake and the Medeiras recreation area at the south side—with a total of 45 covered picnic units with 50 picnic tables and barbeques by the forebay lake. This lake has 14 miles of shoreline and covers 2,000 acres.

San Luis Creek area has a boat ramp, and a lifeguard is on duty during the summer. Many

Swimming and lakeside picnicking provide delightful pastimes at Reclamation's O'Neill Forebay, recreation area operated by the State.

former Indian sites with some house pits have been discovered in the area, and an interpretive trail around the sites is planned.

For those who want to camp overnight, the Medeiras area is available, and it has a boat ramp.

Near the Medeiras area, at the intersection of State highways 207 and 152, is the site for the San Luis Wayside Park—an overnight rest stop for travelers. Trees have been planted in this area.

For those who like more action, two limited hydroplane races, complete with speeds up to 70 miles per hour, flips and spin-outs, have been held at O'Neill Forbay. An unlimited hydroplane race is planned for the future at San Luis Reservoir. It is one of 11 sites in the United States invited to host the event.

The largest recreation area at main San Luis Reservoir covers 925 acres and is called Basalt Area, named after "Basalt Hill" where the basalt rock was excavated for use in San Luis Dam. Newly planted trees add to the beautiful rolling hills of this area.

Swimming Feats

Considerable attention was recently given to long distance swimmers at San Luis Reservoir. A 14-year-old boy, Kurt Miller of the Los Banos Tiger Shark swim team was the first to cross the reservoir. Miller swam it in 3 hours, 24 minutes. He tackled the 5¼-mile breadth and his swim was between 5½ and 5¾ miles long due to water currents and winds. His speed was 1.47 miles per hour.

Another swimmer, Walter R. Fall, a 25-year-old sailor from Lemoore Naval Air Station, swam the long way of the reservoir, a distance of about 7½ miles. He was timed at 4 hours, 4 minutes, and averaged about 1.9 miles per hour.

Because of its favorable swimming conditions, the National Amateur Athletic Union is planning a swim meet on O'Neill Forebay where the water is steadier. About 100 swimmers from age 7 and up, from throughout the Nation will participate.

Los Banos Creek reservoir was the first of the three lakes opened for recreation. It is located 7 miles southwest of Los Banos and 9 miles southeast of San Luis Reservoir on Los Banos Creek.

Purpose of Los Banos Creek Dam is to prevent the creek from flooding San Luis Canal and the city of Los Banos during the rainy season. Covered with grass, this eathfill dam looks like an extension of the pasture below it. Behind the dam, the long lake winds back through a canyon and has a reputation as the best of the three lakes for bluegill.

There are two camping areas along the shore, and a third large one is planned in an area called Padre Arroyo Flat. At this site a long piece of land sweeps majestically out into the lake on one side and rises gently into sloping hills on the other side.

Relax at Overlook

Several vista points overlook the 470-acre Los Banos Creek reservoir along Rim Drive on the south side where there are new tree plantings. Picnickers can relax on the hills overlooking the lake or on the shore.

Because of favorable sailing conditions, a sail-

oat race is planned for Los Banos Creek Lake.

Recreationists have found the Los Banos Creek rea to be interesting for trail riding—up to 150 n organized rides at one time. Overnight trial ides are planned.

Sportsmen claim excellent year-round fishing n all three lakes. Thirty-inch stripers, plus large-nouth black bass, channel catfish, white catfish, unfish and shad are not unusual. Most of the fish, however, are bluegill, crappie, and Sacramento perch.

Fish in the San Luis Reservoir use the old "Uke" (earthmover) tires, placed at the bottom of the reservoir just for them as their individual hatcheries.

The reason the young fish survive and grow rapidly is the unusually rich food content in the water which flows from the Delta-Mendota Canal and the California Aqueduct. Fishermen report that there are many 3- and 4-pound perch in the reservoir.

Stripers up to 27 inches have been caught in the irrigation ditches near Los Banos. The record to date from High Line Canal was a 40-inch, 30-pounder. Because of the fishing success, a number of fishing derbies are being planned for the lakes, various sloughs in nearby wildlife refuges, and 96 miles of fishable canals in the San Luis Recreation Area.

From Romero

A panoramic view of the San Luis Reservoir, with the dam and the O'Neill Forebay in the background is afforded by Romero Overlook. Everything at the San Luis Unit is so huge that it is hard to keep things in perspective and to realize that the earthfill dam is 3½ miles long and can control 2.1 million acre-feet of water. Exhibits and a slide show in the overlook help tell the San Luis story.

Poppies and lupines seen on hills neighboring the Overlook grew wild in the valley before the dam was constructed. To preserve the poppies, the Bureau moved some of the soil containing poppy seeds from the valley to two attractive hills above the reservoir site.

Exhibits and another view of the project are provided at the San Luis Pumping-Generating Plant. This huge building houses eight pump-generators, each of which can generate 53,000 kilowatts of electricity or pump 10.3 thousand gallons of water per second.

Visitors can stand on the seventh floor of the pump-generator plant and see the huge pump-generators in operation. Water which comes to the project via canals from the Sacramento-San Joaquin River Delta, 100 miles to the north, but which is not immediately needed by irrigators and cities is pumped up into San Luis Reservoir from

The lure of horseback riding across open areas of the San Luis Unit attracts members of this newly formed riding club.

Frogs, fish, small animals and about 100 species of birds make use of such nooks as this. Four miles of water provided by Reclamation flows through this National Wildlife Refuge.

O'Neill Forebay to be stored for future use. When the water is released through the plant's turbines, electricity is generated.

1,500-Year-Old Skulls

Among the exhibits in the plant are skulls—one believed to be more than 1,500 years old—and other artifacts dug up and preserved from Yokut Indian sites during construction of the project. Scattered throughout the project are interpretive signs which tell about the project or about Indian sites found there.

Bird watchers enjoy wildlife refuges in the Grasslands Area near Los Banos, a major wintering area for waterfowl in the Pacific Flyway. The refuges, with their ponds and wooded sloughs provide many shady stream banks which are ideal spots for picnicking on hot days. The Bureau provides some of the water needed for the marshes.

A number of the waterfowl now spend part of their time on the San Luis Reservoir—as many as 400,000 have been counted on the reservoir at one time.

There are 287 private duck clubs in the area with some 6,000 members. Several thousand other persons travel to the area to hunt during the migratory waterfowl hunting season, which runs from about October until January. National dog trials (in which the dogs track birds) are planned for the San Luis National Wildlife Refuge. The trials are conducted over a seven-weekend period.

Kinds of Birds

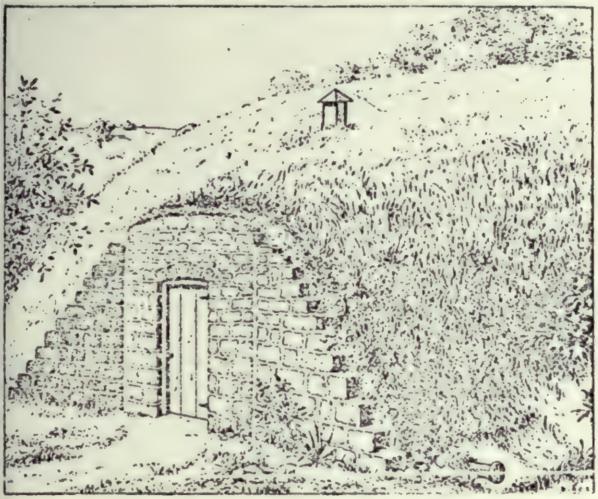
Most of the birds are pintail ducks, although there are many mallards, shovelers, geese, pheasants, mourning doves, whistling swans, and sandpipers, plus some 200 other species on the project. There are a number of great blue heron native to the area as well as golden eagles.

A pair of golden eagles moved into a nest on a tall (141 feet) power tower at O'Neill Forebay—quite a change from their usual remote, high-cliff nesting spots. The nest was built last year by a crow, taken over in February by a redtail hawk, and then by the eagles. Each new "family" has made improvements and additions to the nest. The eagles took turns sitting on the nest—about 5 hours at a time—until the two eggs hatched.

Recreation at San Luis has made an impact on the economy of the area. Because Interstate 5 passes right by the project, it is easily reached from all directions. Estimates show that more than 80 percent of the recreation visitors to the area will be from the Los Angeles and San Francisco Bay metropolitan areas.

Permanent recreation facilities for the expected numerous visitors are being constructed as rapidly as Federal and State funds are made available. Most of the facilities now in operation are classed as temporary. When the permanent facilities are completed—and word is spreading rapidly—the San Luis Recreation Area is expected to be one of the most popular places available to sun- and water-loving Californians. # # #

FIFTY YEARS AGO
in Our Magazine



A well-protected root cellar in a hillside.

APPROPRIATIONS COMMITTEE TO VISIT PROJECTS.

As we go to press plans are being perfected for an inspection trip to several of the national parks and reclamation projects by a number of members of the Committee on Appropriations of the House of Representatives. The following members of the committee and others have signified their intention to make the trip, in whole or in part:

Representatives Good (chairman), Cannon, Wood, Cramton, French, Shreve, Slemp, Byrns of Tennessee, Evans of Montana, Eagan, and Gallivan. Representative Sinnott, chairman of the Committee on Public Lands, will also be one of the party, as will Stephen T. Mather, Director of the National Park Service, Arthur P. Davis, Director of the Reclamation Service; J. B.Beadle, director's assistant; F. E. Weymouth, chief engineer, and R. F. Walter, assistant chief engineer. Mr. Davis will join the committee on the Newlands project. A stenographer and a representative of the railroads will also accompany the committee.

The party plans to leave Chicago at 11.20 p. m., June 20, and to return to that point on July 31. A number of national parks will be visited and the following reclamation projects: June 24, North Platte project; June 26, Newlands project; July 6, Orland project; July 7, Klamath project; July 14, Yakima project; July 15, Umatilla project; July 17, Boise project; July 18, Minidoka project and American Falls; July 20–24, Shoshone and Huntley projects; July 29, Milk River project.

CONGRESSMEN LAUD WORK OF RECLAMATION SERVICE.

Representative N. J. Sinnott, chairman of the Public Lands Committee of the House of Representatives, made the following remarks in the House on May 8, 1920, during the discussion of the provisions in the sundry civil bill relating to the Reclamation Service:

"The Reclamation Service is one of the great activities of the Government. I think that the money invested in the reclamation of arid lands is one of the best investments the Government ever made. It has expended something like $120,000,000 in the reclamation of the arid lands in the 16 Western States and Texas, and, according to the figures given for crop production in the year 1918, there was produced from that investment of something like $120,000,000 about $90,000,000 in that one year. Certainly that is a good investment.

NOTED HERE AND THERE.

Washington, Yakima project.--Dick Klassen recently sold his 40-acre ranch to Mr. Alderman, realizing a profit of $100 an acre on the land. The ranch is located near Outlook, and Mr. Klassen had owned it for only four months. Surely some of the Yakima Valley farmers have touched finger tips with Get-Rich-Quick Wallingford at least once in their

Settlement.--During the month 24 homestead filings were accepted covering 1,585 acres of irrigable lands and 12 private land water-right applications were accepted for a total of 826 acres.

On March 31, under public notice dated March 12, 1920, 19 farm units, covering an irrigable area of 1,415 acres, were thrown open to homestead entry, a 60-day preference right being reserved for soldiers, sailors, and marines. Ten of these units with irrigable areas aggregating 831 acres were filed upon on the opening date. Six tracts of private land involving 446 acres were also made subject to water-right application by this public notice.

STRAWBERRY VALLEY PROJECT, UTAH.

A gang of 15 men and a foreman were sent to the Strawberry tunnel on March 16. Camp was established and 1,000 feet of tunnel floor cleaned. The road from Diamond Switch to the west portal was in poor condition and the last 7 miles was through heavy snow. The electric truck arrived on the last day of the month.

NEWS NOTES

Hungry Horse Prevents Floods

In early June, Hungry Horse Dam in Montana prevented the Flathead River from reaching flood stage at the town of Columbia Falls, as it had also done in late May.

Peak flow of the river was 41,600 cubic feet per second on June 6, but it would have been 71,600 cfs above flood stage had it not been for the dam. In late May, peak flow was 39,700 cfs, but it would have been 65,000 cfs, also above flood stage.

Transmission Line Now In Use

Reclamation's recently completed 345-kilovolt Fort Thompson, S. Dak., to Grand Island, Nebr., transmission line was placed in service last July 3.

The line, which interconnects the Federal power system in the Missouri River Basin and the Nebraska Public Power District, will greatly increase power delivery capability between the systems and provide additional security against blackouts.

Assistant Commissioners Of Reclamation

Commissioner of Reclamation Ellis L. Armstrong took the Annual Programming Conference at Rapid City, S. Dak., during the week of August 17, as the place to disclose his selections for the posts of Assistant Commissioner in the realigned Bureau of Reclamation.

He said Gilbert G. Stamm, Assistant Commissioner for Planning and Irrigation since February 1964, is to be Assistant Commissioner for Resource Management; William H. Keating, who has been Acting Assistant Commissioner for Power and Engineering since last December, is to be Assistant Commissioner for Resource Development; and Warren D. Fairchild, Executive Secretary of the Nebraska Soil and Water Conservation Commission since May 1957, is to be Assistant Commissioner for Resource Planning. Fairchild attended the conference as a consultant at the invitation of Commissioner Armstrong. Wilbur P. Kane, Assistant Commissioner for Administration since August 1963, will continue in that post.

In the photo from left are: William H. Keating, Wilbur P. Kane, Commissioner Armstrong, Warren D. Fairchild, and Gilbert G. Stamm.

Water Study Sent to States

An outline for the Western United States Water Plan Study has been sent to the Governors of the 11 involved States and other interests as the initial step toward preparation of a detailed plan of study. Any comments were requested by last September 1.

Supervising the study is Assistant Secretary James R. Smith and Commissioner of Reclamation Ellis L. Armstrong, who has named Wallace R. Christensen, a Bureau of Reclamation career engineer with 29 years of service, as chief of the study. Christensen will have headquaters in Denver, Colo.

The Western United States Water Plan Study was authorized by Congress in the Colorado River Basin Projects Act.

The study affords the West the greatest opportunity it has ever had to present to the Congress a complete picture of Western water needs.

Former Commissioner Dies

Michael W. Straus, who was Commissioner of the Bureau of Reclamation from 1945 to 1953, died of a heart attack August 9, in Maine where he was spending the summer at his island home.

Seminar on Drugs

A seminar on drugs and drug abuse problems was held last August by the Bureau of Reclamation in cooperation with Brigham Young University for staff members of the Civilian Conservation Centers administered by Reclamation. Staff members from other agencies having Civilian Conservation Center responsibilities also were invited.

Roadside Markets Give Clues

When roadside farm produce stands begin springing up, it is a clue to the growth of a community and the presence of fruit and vegetable crops.

In some cases, those miniature markets also are a result of a Reclamation irrigated area. Due to low population and too little water in Central Washington State there were no such edge-of-town markets a few years ago, but there are now.

One of the advantages of picking strawberries for your own use is that you can eat some right out of the patch, as a young girl found out at the D & D Kissler Berry Farm.

The area has water from Reclamation's Columbia Basin Project.

Probably as family enterprises, in most cases, roadside stands are in operation throughout the Nation. Only a few are located in the Columbia Basin Project, but a recent new comer to the business is Dan Kissler, his son Eric, and their wives, who have started four handy strawberry (soon to include vegetables) stands since 1968. One is at the edge of their 68-acre farm near George, and the others are at Monitor, Ephrata, and Yakima Valley.

Underwater Plant Eating Fish Transplanted on Yuma Project

A native South African fish, tilapia, which eats underwater plants that clog irrigation canals and drains has been transplanted on the Yuma Project at the lower end of the Colorado River.

More than 5,000 of the spiny-rayed fish have been moved from a drain to the main canal on the Yuma Project's Reservation Division in Southeastern California in an effort to control undesirable aquatic plants. The transplant was made by the Bureau of Reclamation and the California Department of Fish and Game.

The tilapia grow rapidly, up to 1.5 inches per month, in warm water to a weight of about 1.5 pounds and reproduce at a high rate. Establishment of the African fish in the canal hopefully will replace present measures of keeping the waterway clear of undesirable aquatic plants that interfere with the flow of water.

Past aquatic plant control for the Reservation Main Canal consisted of chaining, use of chemicals, and drying up the canal by draining. Chaining and use of chemicals are expensive. The chemical kills not only the underwater plants but all living organisms. All eradication measures must be repeated several times a year because of the rapid regrowth of the aquatic plants.

By using a biological control such as the tilapia, expense is kept to a minimum and use of dangerous chemicals is unnecessary. "In addition, the fish provide many hours of sport fishing. In the waterways where the tilapia is established, such as in the Yuma Project's Reservation Drain, aquatic plant growth has been kept at a minimum.

Authorized in 1904, the Yuma Project is among the oldest Bureau of Reclamation developments in this country. About 52,000 of the project's 67,000 cultivated acres lie in Arizona and the remainder in California. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6807	Columbia Basin Wa	July 14	Seven motor-driven Vertical-shaft, turbine-type pumping units for Grand Coulee third powerplant, Sch. 1 and 1A.	Johnston Pump Co. Glendora, Ca	$176,4
DC-6816	do	July 21	Solid-state and miscellaneous electro-mechanical relay cabinets and transfer-trip tone equipment for Grand Coulee 500-kv switchyard and third powerplant.	Westinghouse Electric Corp., Denver, Co.	247.4
DS-6817	do	July 31	Nine 500-kv power circuit breakers for Grand Coulee 500-kv switchyard.	Magrini M.S.M. via Magrini F., Bergamo, Italy.	1,458,0
DS-6822	do	July 23	Three governors for hydraulic turbines for Grand Coulee third powerplant.	Baldwin-Lima-Hamilton Corp., Philadelphia, Pa.	537,7
DC-6823	Central Valley Ca	July 16	Construction of 26 miles of concrete lined San Luis drain and first stage, Kesterson reservoir, San Luis unit.	Gordon H. Ball, Inc. Danville, Ca	7,187,0
DC-6825	do	July 30	Construction and bituminous surfacing of 6.88 miles of access roads for Auburn Dam.	Pacific Excavators, Albany, Co	1,538,3
DC-6828	Missouri River Basin, Mt	July 14	Construction of stage 02 additions to Yellowtail switchyard.	Addison Const. Co., Cheyenne, Wy	554,7
DC-6829	Fry-Ark, Co	Aug. 14	Construction of 3 miles of Nast tunnel, ½ mile of Frying Pan conduit and Lily Pad diversion, Schedules 2, 4, and 5.	Peter Kiewit Sons Co., Omaha, Nb	7,521,6
DC-6830	Missouri River Basin, N.D	July 17	Construction of stage 03 additions to Watford City substation.	Electrical Builders, Inc., Valley City, N.D.	241,8
DC-6831	Fry-Ark, Co	July 31	Construction of 8.6 miles of Cunningham and Mormon-Carter access roads.	Gordon H. Ball, Inc. (Colo. Const. Inc. Dw), Denver, Co.	883,0
DC-6832	do	July 16	Production of sand and aggregate from Twin Meadows aggregate source for western slope features.	Carmack Drilling Co., Grand Junction, Co.	351,2
DC-6833	Central Valley Ca	July 31	Construction of 14.5 miles of concrete lined Falsom canal, Reach 1.	Gordon H. Ball, Inc., Danville, Ca	15,295,0
DC-6834	do	July 31	Construction of Auburn-Foresthill bridge superstructure.	Willamette-Western Corp., Richmond, Ca.	8,990,7
DC-6835	Fry-Ark. Co	Aug. 5	Relocation of 7.9 miles of County road 9 and 9A for Turquoise Lake.	Pinello-Hefner Const. Co., Colo. Springs, Co.	439,8
DC-6837	Missouri River Basin, S.D	Aug. 27	Construction of operation and maintenance shop bldg. for Huron service center area.	Jacobson Const. Co., Huron, S.D	279,71
DC-6839	Fry-Ark. Co	Aug. 20	Excavation of 4.5 miles for Hunter tunnel and construction of Sawyer Creek diversion structure and conduit, Schedules 1 and 3.	Granite Const. Co., Watsonville, Ca.	7,541,05
DC-6840	Missouri River Basin, N.D	Aug. 26	Construction of 12.5 miles of Garrison-Snake Creek 115-kv transmission line.	Brink Const. Co., Rapid City, Sd	353,49
DC-6843	do	Sept. 21	Construction of stage 03 additions to Morris substation.	United Power Contractors and Engrs., Inc.	237,19
DC-6845	Navajo Indian, N.M	Sept. 3	Construction of Cutter Dam	Johnson Bros. Highway and Heavy Constr., Inc., Litchfield, Mn.	2,385,66
DC-6848	Colorado River Storage, Co	Sept. 15	Construction of stage 02 additions to Blue Mesa switchyard.	Electrical Dynamics, Inc., Gunnison, Co.	127,58
100C-1101	Columbia Basin, Wa	July 2	Construction of 18.7 miles of buried pipe drains, Block 87, Schedules 1 and 2.	J.B & C Co., Scottsdale, Az	316,01
100C-1112	do	Aug. 18	Construction of 11.3 miles of buried pipe drains and stabilization of RB4H2 wasteway bank, Block 82.	John M. Keltch, Inc., Pasco, Wa	176,38
100C-1113	do	Aug. 18	Construction of 6.6 miles of buried pipe drains, Block 72.	Ray C. Pickens, Inc., Yakima, Wa	103,70
100C-1116	Teton Basin, Id	Aug. 21	Construction of 1.4 miles of access roads and exploratory earthwork and testing for Teton Dam.	Mitchell Const. Co., Pocatello, Id	114,67
200C-810	Central Valley, Ca	Sept. 18	Removal of sediment from Delta Mendata canal intake channel.	West Coast Dredging, Inc., Martinez, Ca.	152,64
300C-296	Pacific Northwest-Pacific Southwest Intertie, Nv.	Aug. 14	Construction of operation and maintenance facilities for Mead substation.	Crestmont Corp., Las Vegas, Nv	216,19
400C-447	Eden, Wy	July 22	Construction of 5.6 miles of compacted earth lining for Eden area laterals.	C. R. Roberts & Sons., Cokeville, Wy.	122,94
700C-734	Missouri River Basin, Ks	July 20	Construction and surfacing of roadways and parking areas and construction of 10 pit toilets for recreational facilities at Waconda Lake area, Schedules 1 and 2.	Heide-Christolear, Inc., Smith Center, Ks.	178,81
700C-736	Fry-Ark. Co	July 13	Surfacing and improving county road No. 104 and constructing parking area for Ruedi reservoir.	Schmidt Const. Co., Arvada, Co	294,52
700C-738	do	Aug. 11	Furnishing and erecting a prefabricated metal office and laboratory building at Pueblo dam.	H. E. Whitlock, Inc., Pueblo, Co	144,77

U.S. GOVERNMENT PRINTING OFFICE:1970 O—403-432

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

NOTE TO SUBSCRIBER: If your address changes, please notify us of your new address, including Zip Code, and include old address with our code number as shown above.

Street address
Name

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402
OFFICIAL BUSINESS
RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFF

MAIL ORDER FORM To:

Superintendent of Documents, Government Printing Office, Washington, D.C. 20402

Enclosed find $.............. (check, money order, or Supt. of Documents coupons).

Please send me the copies I have indicated below:

...... MINNESOTA. I 1.91:M 66	60¢	...... MARYLAND. I 1.91:M 36
...... ALASKA. I 1.91:Al 15	65¢	...... WEST VIRGINIA. I 1.91:W 52 V
...... TEXAS. I 1.91:T 31	45¢	...... OHIO. I 1.91:Oh 3
...... ARIZONA. I 1.91:Ar 41	45¢	...... WASHINGTON. I 1.91:W 27
...... MASSACHUSETTS. I 1.91:M 38	45¢	...... NEW MEXICO. I 1.91:N 42 M
...... COLORADO. I 1.91:C 71	50¢	...... IDAHO. I 1.91:Id 1
...... OREGON. I 1.91:Or 3	50¢	...... UTAH. I 1.91:Ut 1
...... NEVADA. I 1.91:N 41	45¢	...... WYOMING. I 1.91:W 99
...... CALIFORNIA. I 1.91:C 12	60¢	...... SOUTH DAKOTA. I 1.91:So 8 D
...... MONTANA. I 1.91:M 76	50¢	...... INDIANA. I 1.91:In 2
...... PENNSYLVANIA. I 1.91:P 38	65¢	...... NORTH DAKOTA. I 1.91:N 81 D

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DC

[illegible]

MINNESOTA

[illegible]

[illegible]

February 19

RECLAMATION era

A WATER REVIEW QUARTERLY

Feb. 1971 • Vol. 57, No. 1

RECLAMATION
era

Gordon J. Forsyth, Editor

CONTENTS

COVER. Skiers at Purgatory Ski Area make good use of the snowcapped San Juan Mountains near Durango, Colo. In spring this snow provides a major source of water for operation of a Reclamation project.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

Commissioner's Page

Far Reaching Water Plan

The Bureau of Reclamation has been given responsibility for one of the most far reaching water studies ever undertaken. This is the Western U.S. Water Plan Study.

The scope of this landmark study goes far beyond the routine determination of local water needs and ways of meeting them. It is a full and complete reconnaissance to develop a general plan to meet the future water needs of the Western United States.

Because the West still has great growth potentiality and a unique environment that must be protected, it is appropriate that such a study take place in that region. It has been the fastest growing part of the Nation in recent years, and it still has potential for new communities with excellent environment advantages.

The vital water developments which have brought crop variety and dependable production to millions of acres of irrigated land could do the same to many more millions of acres. The West also is highly attractive because it still embraces a variety of great open spaces, outstanding scenic beauty, and untapped natural resources.

A first objective of the Westwide Study is to project the West of the future—its population, industry, agriculture, environment, and social makeup. A second objective is to determine water supply from all available sources. A third is to translate this projection of future conditions into water requirements and balance them against the available and potential water supply. Of course there is interaction in all three of these objectives.

The final and ultimate phase of the study is to develop a plan to meet these water needs in an optimum manner so that our children and our children's children may have a better quality of living just as we today are enjoying the fruits of our forefathers' labor.

It is not solely a Bureau of Reclamation study, although we have primary responsibility. It must have input from other Federal agencies and particularly from the States and their related agencies.

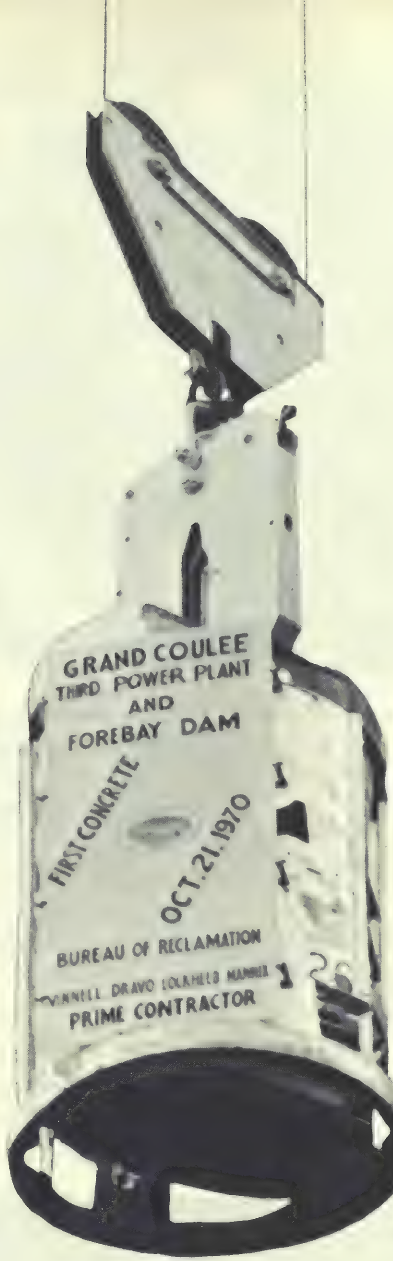
Research will play a major role in the study, and we are broadening our own research efforts and expect to obtain specialized research assistance.

I have a deep personal interest in the westwide study. I feel that Reclamation's experience, our staff of specialists in all essential disciplines, including ecologist and environmentalist scientists, will result in the successful completion of the plan which will help develop a better America for future generations.

ELLIS L. ARMSTRONG
Commissioner of Reclamation

Ceremony starts huge operation

THIRD POWERPLANT GETS FIRST CONCRETE



FIRST concrete placement was made at the Third Powerplant at Grand Coulee Dam, Wash., on October 21 with participation by Reclamation Commissioner Ellis L. Armstrong as master of ceremonies.

Pushing the button which released the first batch of concrete at exactly noon were Commissioner Armstrong; Henry M. Jackson, U.S. Senator from Washington; Thomas S. Foley of the U.S. House of Representatives from Washington; Catherine May who was then a Member of the U.S. House of Representatives from Washington; and former Senator C. C. Dill.

Before the dedication ceremony, attended by an estimated 2,500 persons, more than 10 million cubic yards of excavation already had been accomplished on the project—under the largest single construction contract ever awarded by the Bureau of Reclamation.

Senator Jackson was principal speaker, and a special letter from President Richard M. Nixon was read. The President wrote:

"The event marks a singularly important step in the Hydro-Thermal Power Program of the Pacific Northwest. This Administration enthusiastically endorsed this program 1 year ago. I am pleased that the Congress provided the authority and the funds necessary to construct this third unit because it will play a vital role in assuring the continued, adequate, and orderly development of our electric power resources.

"Present and future generations will benefit from this plant. It will aid those who will follow us in developing the entire Columbia Basin area—turning its brown, arid land green with the production of food for our people and peoples throughout the world.

"My heartiest congratulations to all of those who worked so long and hard in making this project a reality."

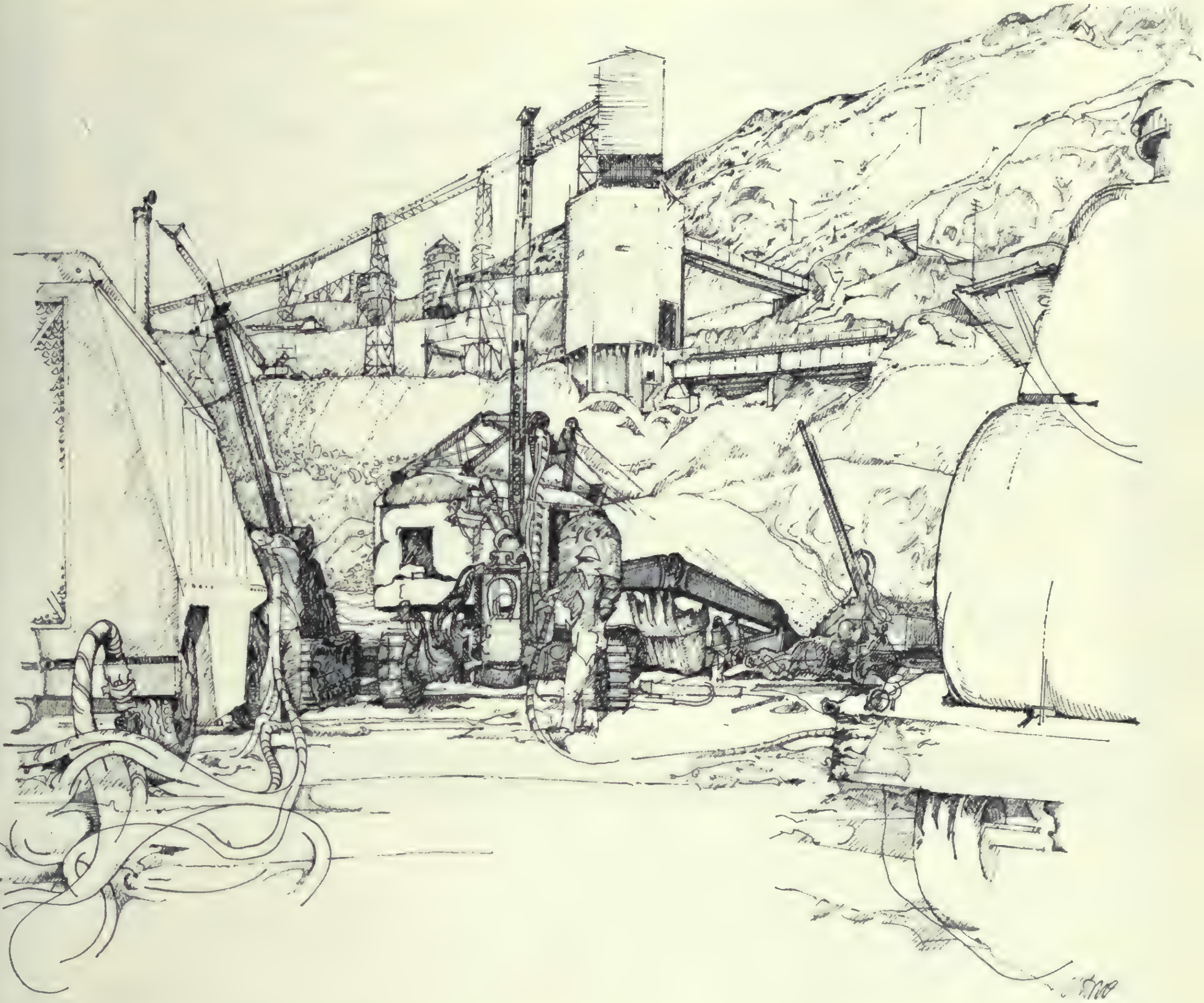
Dignitaries who participated in the first concrete ceremonies are from left, Congressman T. S. Foley; former Congresswoman Catherine May; Senator H. M. Jackson; Commissioner E. L. Armstrong; former Senator C. C. Dill, and R. J. Jenks, Project Manager for the joint venture of Vinnell-Dravo-Lockhead-Mannix.

Viewed From Rim

During the ceremony many construction workers stood on platforms high on the granite cliff and on top of the rim several hundred feet above the site where the first concrete was poured.

This first pour was at the deepest point of excavation and officials said concrete now will be poured continuously for 2 to 3 years. The joint venture of Vinnell-Dravo-Lockheed-Mannix anticipates completion of work so that power from the first of six 600,000-kilowatt generators can be operative in February 1974.

Two well-known artists, Alfred McAdams of the Smithsonian Institute, Washington, D.C., and Fletcher Martin of Woodstock, N.Y., visited Grand Coulee Dam only 2 weeks before the October ceremony. Impressed with the gigantic construction effort, they artfully sketched some of the vivid scenes which follow herein. Mr. McAdams' drawings are on pages 3; 4 (bottom); 5 and 7; and Mr. Martin's are on pages 4 (top), and 6.



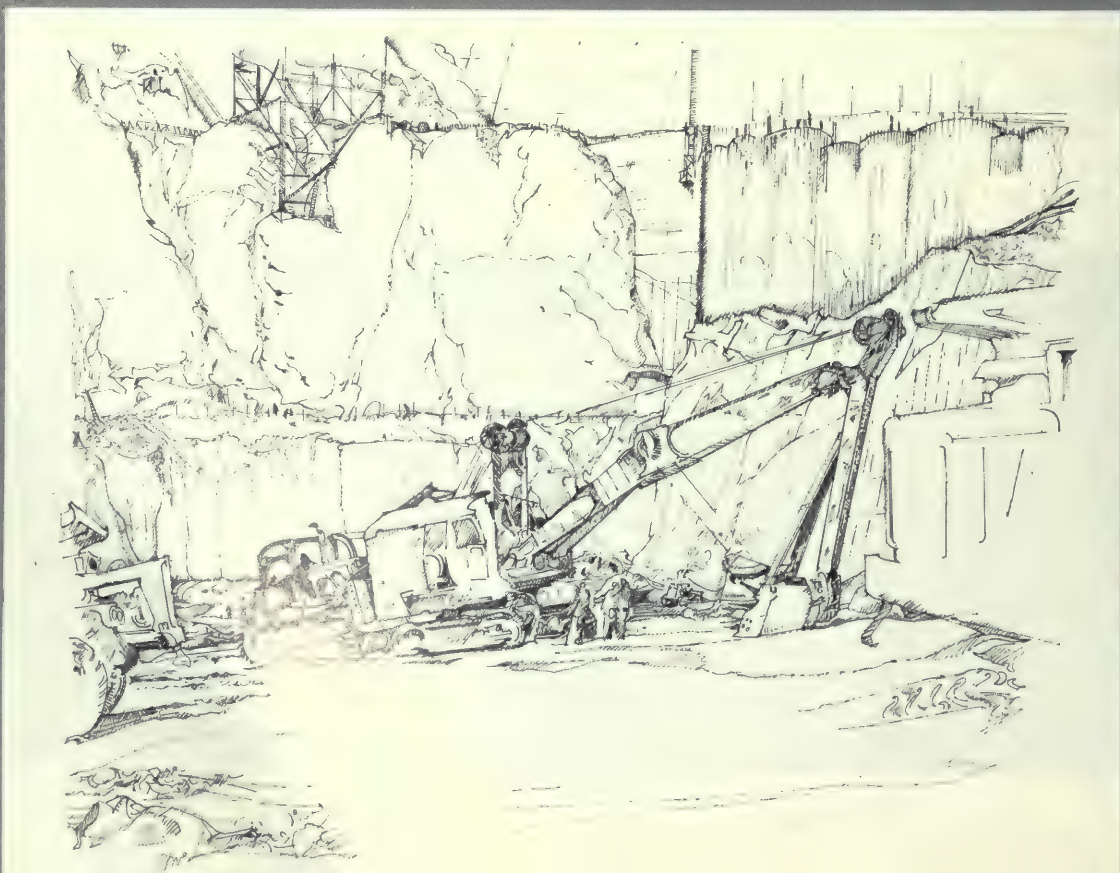
BEFORE THE POUR This drawing was made in early October 1970, about two weeks before the first pour took place for the foundation of the Grand Coulee Third Powerplant. The area shown is near the site of the first pour.

Construction workers are operating drill rigs, used to bore vertical holes in the solid granite foundation rock. Dynamite is then placed in the holes, the area is cleared of workers, and the "shot" is detonated. The shots are usually detonated at the end of each of three round-the-clock shifts. The workers leave the area to go off-duty before the blast and the next shift moves in to clear out the shattered rock and debris, drill a new set of holes, and place more dynamite for the next detonation.

The three rigs depicted in this scene, with drill arms rising obliquely in the center foreground, are operated by compressed air from mobile units with air hoses shown in right and left foreground.

At top center is the batch plant, where the concrete was mixed for the initial pour for the foundation of the structure.

wet sand
Danger
Keep out
Explosives



Top left—DYNAMITERS Dynamite men are shown here "stemming" newly drilled foundation holes. Charges of dynamite are tamped into the holes by means of long steel rods, shown vertically in the drawing. A layer of wet sand is packed on top of each stick of dynamite. This is followed by another dynamite charge topped by another layer of wet sand, and the process is repeated until the hole is fully charged.

Primacord fuses attached to each charge lead to a juncture position well out of the picture. Then the area is cleared of personnel and the dynamite is exploded simultaneously, blasting loose a layer of solid rock. Lighted fuses are used for exploding the dynamite in preference to electrical detonations for reasons of safety.

Because the Grand Coulee area is charged with high voltage power lines, the use of an electrical detonation system would carry with it the hazard of premature explosions caused by stray electrical currents.

Bottom left—WHERE THE POUR BEGAN A backhoe is shown as it scooped up shattered granite and debris following a "shot" deep into base rock. The blasted material is loaded into giant dump trucks and hauled downstream where it is used to raise and fortify the embankments of the Columbia River. The strengthened embankments will be needed when flows released through the Third Powerplant raise the river above normal levels.

Shown at left foreground is the nose of one of the massive dump trucks having a capacity of 50 tons of material per load.

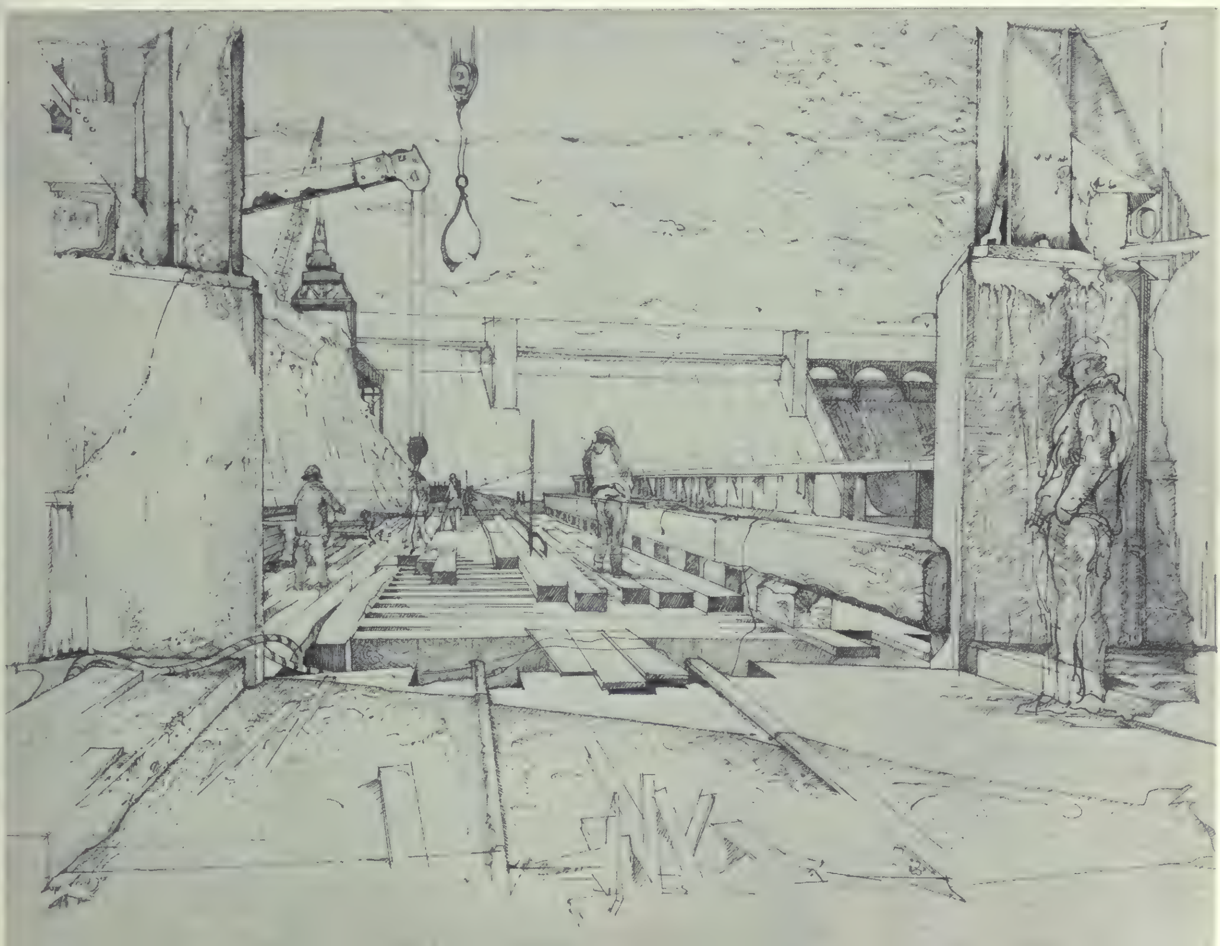
At upper right is the cellular coffer dam which holds back the waters of Franklin D. Roosevelt Lake during construction of the forebay dam for the Third Powerplant. The forebay dam will rise from the base of the granite wall in the center of this drawing and will extend to meet the right wing of Grand Coulee Dam, just out of the scene to the upper right.

Below—FROM THE BATCH PLANT A view from the open doorway of the "batch" plant, where the concrete is mixed for construction of the powerplant and forebay dam. Workmen are placing beams on a trestle leading from the plant to a roadway in the background. This will be a railroad over which trestle cars will convey three buckets of concrete at a time from the plant to the construction area.

At upper left is a whirli-crane which moves along a steel trestle parallel to the axis of the forebay dam. The whirli-crane, capable of revolving around the compass, will lift the 8-ton buckets of concrete from the trestle cars and swing them into position for pouring.

To the right, and below the level of this drawing, other whirli-cranes will lift their arms over the roadway to pluck buckets of concrete off the trestle cars for pouring into the foundation of the Third Powerplant itself.

Shown in the upper background are the right wing of Grand Coulee Dam and a portion of the spillway.




Fletcher Martin

Above—**PENSTOCK ASSEMBLY** Giant steel penstocks which will convey water from the forebay dam to the Third Powerplant turbines are being assembled. This drawing shows a number of 40-foot diameter penstock sections which will be welded together. The stiff-leg derrick, center of drawing, lowers one huge section over a matching section for the welding effort.

The penstock assemblages will then be lowered into granite slots cut out of the rock face leading from the forebay level down to the Third Powerplant level and further welded together.

This assembling area is on the floor of the forebay site, which will be under some 180 feet of water on completion of the forebay dam and removal of the cellular coffer dam seen in upper background.

The forebay dam will be a diagonal structure joining the completed section of Grand Coulee Dam, top center. The Third Powerplant, now under construction, is also off to the right of the drawing and some 200 feet below the level of this scene. # # #

Left—**SEALING THE CREVICE** A geological fault being cleared of an accumulation of rocks and debris then plugged with concrete backfilling is part of the Third Powerplant construction. Working at the base of the crevice, a backhoe scoops out loose material.

A large rectangular section of the backfill already is completed. The crevice being made watertight will extend upward to beyond the maximum water surface level of the forebay reservoir, some 180 feet above.

Two other smaller faults in the granite wall, not shown in this drawing, are being sealed in like fashion in the process of readying the reservoir area for filling.

Reclamation joins
Johnny Horizon efforts

SOME EYESORES ARE GONE

by GORDON J. FORSYTH, Washington, D.C.

A 4–H club girl at work at Swanson Lake, Nebr.

THE white blanket of this winter's snows is hiding from view a number of Man's environmental eyesores. That favor has been performed for Man where snow falls as long as any of us can remember.

But the spring of 1971 will be a little different than other springs have been. There were 497 truckloads of trash, junk, and garbage eliminated from view shortly before snowfall last October.

The areas which were "spruced up" last October looked attractive right away, and when the snow melts in 1971, the clean areas will, hopefully, still be appealing to the eyes of passers-by. The loads of trash were picked up by, and under the supervision of Bureau of Reclamation employees on or near 11 beautiful or often-seen portions of Federal Reclamation facilities.

The cleanup campaign last fall took place on a nationwide scale. The effort was stimulated by a growing environmental awareness, and by the Johnny Horizon program rallying cry, "This is your land, keep it clean," and it is strongly encouraged to become an adopted and continuous activity of everyone throughout the country.

Johnny An Outdoorsman

Created by the Bureau of Land Management of the Department of the Interior, the Johnny Horizon program is now a Department-wide program. It is symbolized by the pe[illegible]ge of an outdoorsman, antilitter advocat[illegible]ped that the dauntless, trim appearance o[illegible] Horizon will inspire people to trim away practices of litter and pollution. Another desired result is full assistance and support by all organizations which are able to do so.

The Johnny Horizon pledge applies equally to city parks, mountain peaks, streams, and wilderness:

> To keep the land clean and free of litter,
> To respect the land and treat it as your own,
> To leave gates and fences as you find them,
> To obey State game and fish laws,
> And to be careful of fires.

Reclamation's participation in cleanup last fall was under two related programs which are reported jointly herein. One program, the Johnny Horizon Countryside Cleanup, included cooperative volunteer work by Reclamation employees and some vehicles during off-duty hours on October weekends.

The other program was the effort of the simultaneous but separately designated Environmental Quality Week of Reclamation's four Job Corps Civilian Conservation Centers. Most of the latter efforts took place in about 7 consecutive days of on-duty and off-duty time as the jobs and weather dictated.

Helped On Alert

Newspapers and radio stations alerted the populations helpfully on both of the efforts in many communities of Western States.

lot of trash was gathered from this road near Moses Lake, Wash., by Corpsmen of the Center at Columbia Basin.

About 480 Bureau of Reclamation employees, nd Job Corpsmen training with Reclamation, doated 1,980 man-days of time to the cleanup and ommunity help efforts, according to available ewspaper reports.

There were at least 18 Reclamation vehicles, ostly trucks and bulldozers, in at least 11 main eclamation areas of the West utilized in hauling nd burying the 497 truckloads of litter.

During isolated fun seeking events, litter doesn't mount to much. But lumped together after a sumer of recreation, the trash adds up to a major roblem at southwest Nebraska reservoirs. From summer of fun at Swanson Lake, Nebr., several ruckloads of debris were toted away one Saturday hen some 35 4-H'ers and leaders as well as peronnel of the Bureau of Reclamation and the State ame Commission turned out for the occasion. Bill Brown of a Reclamation office in the area said the ope is that the lake users will eventually learn hat anything dumped at the lake has to be picked p by someone, and that it is easier and keeps our kes more beautiful if it is carried away by the ser.

For the seventh and eighth grade students from renton, Nebr., the afternoon was not completely illed with trash.

nteresting Artifacts

Ricky Grigg of Trenton found an Indian spearead and another possible artifact that were of particular interest since the group was currently studying ancient history. Marilea Cole found some interesting big teeth that as yet have not been identified as to origin. Other items of interest were a 10-foot exhaust pipe, some shells, and an 8-pound dead catfish.

In a scenic area adjacent to Flaming Gorge recreation area in Wyoming, the noise of heavy equipment heard by nearby Green River residents signaled the work of the cleanup campaign.

Participants were amazed at the amount of litter including everything from animal carcasses to car bodies, which were strewn on the landscape. Several hundred tons of debris and filth were buried in an effort to restore the landscape to its original beauty. Aided by the Bureau of Land Management, the Bureau of Reclamation, and the Boy Scouts of America, the smoothly cleared area was reseeded for greenery.

Cleanup and beautifying projects were conducted in and around Grand Junction, Colo. Included were Lincoln Park, Vega Dam recreation area, Collbran's city refuse disposal area, Cottonwood Lakes campgrounds, Bonham Lake camping areas, Rifle reservoir camping areas, and other recreation areas. Contributing to the effort before the heavy snowstorm curtailed activities on October 7, were men from Reclamation's Collbran Job Corps Conservation Center. The young men completed 150 man-days of work and the staff of the Center completed 75 man-days.

Commendation

An example of how Job Corpsmen's environmental quality efforts were appreciated is shown by a commendation from Mayor Le Roy H. Poll of South Weber, Utah. The *Ogden Standard-Examiner*, Utah said:

"Despite cold temperatures, volunteers from the Bureau of Reclamation's Weber Basin Job Corps Conservtaion Center and Thiokol Chemical Co.'s Clearfield Job Corps Training Center have spent many hours on the muddy reservoir (Pine View) floor, removing hazards. It is a fine project."

Some 200 young men and 25 staff members from the Weber Basin Center also participated with local citizens in various other cleanup projects in South Weber, Ogden, Roy, Farmington, and Bountiful.

They removed trash and weeds from roads and stream beds, helped with park development and aided at several other areas. Corpsmen used heavy equipment to help cities get started on parks, clearing vacant, weed-covered lots.

Corpsmen chipped in with other volunteers to clean the grounds and trim trees around where the Head Start school is headquartered in Ogden, Utah, and the carpentry division at the Center is building shelves for the school.

Corpsmen in the union painting program are doing work for the volunteer fire departments in South Weber and Roy City, Utah. Young men in the brick and masonry group are doing some brickwork for the Boy Scouts at Camp Kiesel.

Two corpsmen crews worked with the Farmington, Utah, Street Department and a Boy Scout troop to clear a planned city park area, then spread top soil on it ready for landscaping.

On the sunny day—girls in slacks and shirttails out, boys and men in jeans also with shirttails out and some with floppy hats—is the way some groups dressed in the warm Southwest. Each person carried one or two gunny sacks or litter bags.

Organized at Boulder City

In the Boulder City, Nev., area, Reclamation employees conducted a "police up" effort. They organized their children, 4-H Club girls and Boy Scouts and worked a total of 120 hours removing 11 truckloads of litter from along [illegible] miles of highway and railroad track near Boulder City and Lake Mead National Recreation Area. Examples of items they picked up and hauled a[illegible]re long pieces of steel cable, paper, cardboard, rags, cans, bottles, old buckets, and rubber tires.

A longer range cleanup effort is underway along the Colorado River about 5 miles from Blythe, Calif. This work is by Reclamation employees in the supplemental training and employment program (STEP), headquartered at Reclamation's office near Blythe, cosponsored by the California State Department of Human Resources Development.

These men and other Reclamation representatives, completed about 80 man-days in the removal of 45 cubic yards of litter and brush from 40 acres of land, and in installing fifty 55-gallon trash barrels at various places along the river where many travelers use them.

For over 2 years the project office has been collecting the trash left along the river by visitors. Heaviest use of the areas is by fishermen and campers on holidays and weekends. Future work for the STEP employees will include painting and tethering the barrels, which ultimately will total about 100.

Filled Eight Trucks

In Indio, Calif., campaign volunteers filled over 1,000 35-gallon sacks with trash from Box Canyon, filling eight trucks for removal to a dumping area.

One of the largest cleanup efforts ever conducted in Tahoe National Forest and Donner Lake area was carried out under direction of H. J. (Ide) Geroy, Reclamation administrative officer from Auburn, according to the Press Tribune newspaper of Roseville, Calif. Mr. Geroy utilized the cooperation of 400 Boy Scouts and their leaders, representatives of the Big Bend and Truckee District Ranger Stations, and the Forest Service.

Tons of litter—about 75 cubic yards consisting of everything from gum wrappers and beer cans to old washing machines and car bodies—the amount accumulated along the otherwise scenic Highway 40 for pickup by dump trucks was so huge that they were still working on Sunday and finally had to enlist the help of the State Highway Department.

Prior to the invasion by 400 Boy Scouts, the hundreds of rocks on the sidehill along the highway showed 8 years accumulation of painted initials and other defacement. The cleanup crews grouted over the face of the rocks with cement and hoped it would never be necessary again.

Getting together of community volunteers and Corpsmen from the Weber Basin Center to clean the grounds of a Commmunity Action Program Head Start center, are from left, volunteers Jose Gurule, Linda Miller, Virginia Archuleta, and Edna Dagsen; Corpsman David Brown; Volunteer Arabell Fox; Corpsmen Donald Porter, James Caldwell, and Ronald Staten.

This scenic area at Grand Mesa, Colo., is getting a cleaning by Corpsmen from the Collbran Job Corps Center.

A dead catfifish is part of the debris found by these 4–H members at Swanson Lake, Nebr.

Dan Applegate (pointing), Reclamation supervisory employee, discussed plans for cleaning up an old trash dump near Lake Lowell, Idaho, with representatives of Federal, State and County agencies, and the Marsing Job Corps Center. This planning resulted in completely cleaning up the dump.

Two television channels in Boise, Idaho, showed short scenes of the Marsing corpsmen as they completed about 248 man-days of work during Environmental Improvement Week, October 2–9. Newspapers and radio stations also carried many of the operations. About 70 Bureau representatives participated, and the use of about 10 vehicles was donated.

Marsing enrollees and leaders helped eliminate two old garbage dumps by burial. The trash from about 20 miles of road and the faces of two small dams amounted to 33 truckloads. The workers painted 9,500 square feet of wall surface on one project, hung over 2,000 square feet of sheetrock, framed 150 linear feet of partitions, installed seven door jambs, and hung the doors complete with hardware on another project. They also prepared the subbase for a basketball court on a small neighborhood playground and got it ready for paving.

Six Acres Cleaned

A concerted effort was made to stop the dumping of trash in the old gravel pit near the recreation area of Lake Lowell, Idaho. It had old car bodies, tree stumps, and other debris of various ages scattered over about 6 acres. Cleanup resulted in getting rid of the eyesores. The Boise Board of Control and the Bureau of Sport Fisheries and Wildlife each furnished one bulldozer and an operator; and the Marsing Center, two bulldozers, an instructor, and seven corpsmen operators. If the recommendation of the Center are approved the area will be fenced to keep dumpers out.

In Washington State 150 Job Corpsmen and 25 staff members of the Columbia Basin Job Corps Center cleared garbage dumps at Moses Lake, and litter from along 38 miles of roadway. They also removed an old gatehouse from the entrance of Larson Air Force Base to allow better visibility, picked up trash on McConine Flats filling 550 plastic sacks, and hauled away at least 24 dump truckloads. At the Center the men are preparing 30 litter barrels in cooperation with 4-H Clubs. Appreciation for the efforts was expressed by newspapers and a radio station at Moses Lake.

Many people strongly hope that the growing environmental awareness of people, and the efforts of the Johnny Horizon program will make it unnecessary to go to the expense and take the time again to reclean the sites they made better in 1970. # # #

A truck load of trash picked up at Swanson Lake.

WATER Quiz

[1] This is a carved image of the god of water ← called Tlaloc. What people of early Mexican heritage does it come from?

[2] Aquarius is a name given ages ago to a constellation which has been meaningful as part of the zodiac depicting a man pouring water. What does the word Aquarius mean?

[3] Recreation visits are enjoyed at more than one reservoir on some of Reclamation's 148 projects in operation. With that clue, how many reservoirs would you suppose had recreational use in 1969?

a. 153
b. 237
c. 241

[4] This peanut farmer, and a few others in the ← Fort Cobb area of Oklahoma, arranged to irrigate temporarily last August because of drought conditions, with water from the municipal and domestic water supplies behind Reclamation's nearby Fort Cobb Dam. Do you figure:

a. They try to grow the peanuts as dry-farm operations?
b. The farmers had irrigated from private wells until the water got too low?

ANSWERS:

1. Aztec; 2. Watercarrier; 3. b. 237; 4. b. They irrigated from wells until the water got too low.

Successful food production from waste water/heat/land

Conquest of Wastes Show Productivity

GIANT bubbles of plastic are being kept mysteriously inflated on the coast of northern Mexico, inside an unusual conquest of waste is going on.

The giant plastic bubbles are a new type of greenhouse which create the ideal environment for using would-be waste water, waste land area, and waste heat to grow food crops.

Waste heat from engine-driven electric generators is used to desalt sea water. In turn, the fresh water is piped with fertilizer to vegetable plants growing in sterile beach sand.

The "experimental food factory" is located at the University of Sonora research station at Puerto Penasco on the Gulf of California. Staff members Carl O. Hodge and Dr. A. Richard Kassander, Jr., of the University of Arizona Environmental Research Laboratory conceived the idea. Arrangements were made to develop the idea at this coastal location in collaboration with the University of Sonora, under sponsorship of the Rockefeller Foundation.

Mr. Hodge and Dr. Kassander believe the concept to be adaptable to vast regions where almost nothing now grows—and where desalted water remains prohibitively expensive for open-field agriculture. Construction has begun, under the laboratory's direction, on the first large-scale installation—in the Arabian Peninsula Shaikhdom of Abu Dhabi on the Persian Gulf.

At the plant in northwest Mexico, 2,400 gallons a day of pure water are wrested from the sea. Since the power/water/food research started in mid-1968, lettuce, peppers, tomatoes, and many other vegetables, as well as melons and strawberries, have been harvested from greenhouses.

The air-inflated greenhouses, compared with conventional structures, are relatively inexpensive and easy to assemble. Lacking beams or other supports, they admit more sunlight. But the principal advantage of the concept for arid regions is extreme conservation of water.

Moisture lost from field crops, by evaporation and transpiration, is enormous. In a closed system, this moisture can be captured. Estimates are that a plant within such a sealed-in environment uses only about a tenth as much water as it would need outdoors.

Greenhouses

Light-stabilized 12-mil polyethylene covers the eight greenhouses. Each building is 100-feet-long, 23-feet-wide, and they are connected in pairs by a concrete tunnel. The tillable space in each house totals 4,600 square feet.

In a corner of each house is a packed-column heat exchanger. These are low, honeycomb-like stacks of corrugated asbestos through which salt water is sprayed.

The environment is closed, without any exchange with outside air. Inside, the air circulates counterclockwise. It flows the length of the house, is deflected through the center tunnel and then repeats the process in an endless double-oval pattern.

The same trapped air sweeps repeatedly through the moist packed column, becoming almost saturated with water vapor. The humidity hovers close to 100 percent, and temperatures may be controlled to a considerable extent by moderating the temperature of the water and airflow rate.

During the winter, some of the sea water evaporates into the airstream and condenses inside the plastic cover of the greenhouses. This condensation exceeds by far the amount of water the plants consume. The result, in colder months, is a net production in the greenhouses of fresh water from salt water.

In order to keep the greenhouses from collapsing, personnel must enter them through air locks. Inflation blowers maintain an interior pressure generally of .01 to .02 pounds per square inch; although this is a function of ambient wind velocity. When external wind speed increases or decreases, the pressure inside is raised or lowered automatically.

Seawater Well And Pump

A 600 gallon-a-minute pump feeds sea water from a well into both the desalting unit and the greenhouses, where it is utilized to maintain temperature and humidity control.

There are two major reasons for a well at this facility. In the Gulf of California, the tidal range is enormous, with a maximum variation of about 28 feet. Consequently, approximately 1,000 feet of pipe would have to be extended seaward from the shore to reach the low-tide point. More important to the power/water/food concept, a constant year-around water temperature (about 76° to 78° F.) can be assured by drawing water from a well rather than directly from the ocean. This means the untreated sea water can be used, at a predictable temperature, to cool crops in the greenhouses.

The well is 78 feet deep. The aquifer is 30 feet below mean sea level.

Powerplant

Two 90-kilowatt diesel electric generator units are the station's power source, required for lighting and pumping. Such generators ordinarily expel to the atmosphere—and therefore waste—about two-thirds of the energy they produce. Here, however, this would-be waste energy is captured by attaching heat exchangers to the diesel engine, and thus is used in the desalting process. In the humidification-cycle process developed by the Environmental Research Laboratory, the powerplant is one of three components. The others are an evaporator tower and a condenser tower.

Evaporator

Hot sea water cascades down the packed-column evaporator through loose piles of small plastic "saddles"—and countercurrent to a rapidly rising stream of air. This turns the air into a salt-free vapor that moves up and across the condenser.

Meanwhile, the remaining warm, untreated sea water (about 9 out of every 10 gallons taken into the evaporator) falls to the bottom of the tower. From there, it usually is flushed back into the Gulf, although it can be detoured through the greenhouses to provide heating, if needed, for the crops.

Condenser

Sea water from the well first enters the desalting system at the bottom of the condenser (the square tower) and is pumped upward through finned tubes. Because the sea water is cool, the vapor that has flowed over from the evaporator forms on the tubing as fresh-water condensate and rains down to the base, where it can be collected.

At the same time, the sea water that serpentines up through the condenser has been warmed by latent cooling of the surrounding saturated air. It then moves to the powerplant, and the excess energy of the engine heats it to 170° F. It is with this hot sea water, piped back to the top of the evaporator, that the cycle begins.

Bottling Plant

The desalting plant produces considerably more distilled water than the agricultural experiments require. This surplus potable water is bottled under the trade name of "Agua Solar." Much of it is contributed to the local hospitals and schools, and the remainder is sold (for 32¢ per 5 gallons) in Puerto Penasco. Any profits that accrue are used to help defray expenses of the research station.

Nutrient House

Since the beach sand in which the experimental crops are grown is sterile, fertilizers must be added. This is done by preparing the necessary nutrients in the nutrient house, and then adding them in tanks in the greenhouses to the water which irrigates the crops.

Plant Nursery

A number of plants, among them beans, broccoli, and melons, are seeded and allowed to germinate in the nursery (and some then potted in peat pots) before they are transplanted in the greenhouses. But a few, including radishes, spinach, and beets, are seeded directly into sand in the greenhouses. # # #

Rogers Morton Named as Secretary of the Interior

Rogers C. B. Morton has been named Secretary of the Interior by President Richard M. Nixon.

Mr. Morton was formerly a Representative in Congress from Maryland, and at one time was a member of the House Interior and Insular Affairs Committee. As one who always held a special fascination for outdoor life, Secretary Morton said he looks forward to the time he would serve at the Department of the Interior.

Tipton Award Winner

Commissioner of Reclamation Ellis L. Armstrong has been named recipient of the Royce J. Tipton Award of the American Society of Civil Engineers. The citation says Mr. Armstrong "has made outstanding contributions to civil engineering in the fields of planning, design, construction, and management of irrigation and drainage work throughout the world."

Commissioner Armstrong is the sixth winner of the award.

Symposium On Man-Made Lakes

An international symposium on man-made lakes, their problems and environmental effects will be held at Knoxville, Tenn., next May 3 to 7. The conference should be of interest to a broad range of scientists, engineers, and project managers. Registration details are available from Dr. William C. Ackermann, president, Scientific Committee on Water Research, Illinois State Water Survey, Box 232, Urbana, Ill. 61801, U.S.A.

Women Engineers Do Their Own Thing

DOING your "own thing" may encompass a great many things, but in the case of civil engineer Miss Toby Ann Levy it means becoming one of the first women engineers ever employed by the Bureau of Reclamation working directly in heavy construction.

Miss Levy was recently assigned permanently to the Field Engineering Division of the Third Powerplant Construction Office, Washington, as a civil engineer responsible for providing inspection and engineering control over a phase of contractor operations.

Also doing their own thing in traditionally men's technical professions are three other women employees, Irene Sharpe, Enid Johannes (architect), and Francis Barnett (architect), who are serving in the Structural and Architectural Branch at the Engineering and Research Center, Denver, Colo. Mrs. Sharpe, a negro, has been an electrical engineer with Reclamation for 5 years. She holds officer positions in the Society of Women Engineers and the Association of Federal Professional and Administrative Women. She attended a national conference of the SWE last summer in Hartford, Conn.

Levy Earned Degree

As the most recent woman to take a technical Reclamation position, Toby Ann Levy had 5 years of intensive professional training. She entered Oregon State University in September 1965, and received her bachelor of science degree in 1969.

During the summer of 1969, Miss Levy studied at Portland State University and the summer of 1968 was spent in Spain studying at the University of Madrid. Since June 1969, Miss Levy has been working at the Third Powerplant construction office in the engineer rotation program. This Reclamation program is designed to provide the graduate engineer with versatile and in-depth engineering training and experience.

Having successfully completed her program in all phases of field and office engineering, Miss Levy expressed her desire to work out-of-doors, in the field, "where the action is."

Because she had clearly demonstrated her technical competence to do the job, the only remaining question was in assigning a female to a traditionally all-male profession. Now that Miss Levy has been on the job for some months, the novelty of a woman engineer in the field has worn off.

However, lest anyone overlook that Miss Levy is a woman, in a day when long flowing hair is also worn by men, she has added a typically feminine touch to her hard hat—a large red bow firmly affixed to the back of the hat! # # #

Miss Toby Ann Levy, Civil Engineer

FIFTY YEARS AGO

in Our Magazine

SOUTH AFRICAN ENGINEER TO BE ASSIGNED TO RECLAMATION SERVICE.

Secretary Payne is in receipt of the following cablegram from the director of irrigation, Pretoria, South Africa:

"Union Government, South Africa, anxious to get your authority to post assistant engineer, irrigation department, for one year's experience on construction works, United States Reclamation Service. Intention is young officer this Service to gain technical experience in actual construction. Appointment will be scholarship from this Government and Reclamation Service will be put to no expense. Desire him to go from work to work under construction to study designs, methods, and application. Kindly cable reply as anxious to send him at once."

To which Secretary Payne replied as follows:

"Assignment irrigation officer is authorized with pleasure."

The Reclamation Service welcomes this opportunity to cooperate with the irrigation department of South Africa in extending the benefits of irrition development to the far corners of the earth.

DUCKS KEEP LATERAL CLEAN.

Mr. J. A. Latimer, of Delta, Colo., a water user on the Uncompahgre project, writes as follows:

About 18 years ago it was very sultry and hot and the moss grew worse that year than others. I had 89 ducks; they fed themselves and kept one-half mile of ditch entirely free from moss. I never had any trouble, while others could hardly keep water running.

COURTESIES APPRECIATED BY FOREIGN REPRESENTATIVE.

REPUBLICA ARGENTINA,
MINISTERIO DE OBRAS PUBLICAS,
DIRECCION GENERAL DE IRRIGATION,
New York City, November 25, 1920.

MR. MORRIS BIEN,
Assistant Director of the
U. S. Reclamation Service,
Washington, D. C.

SIR: I am very sorry to tell you that it is impossible for me to come to Washington personally, and express to you my gratitude for your kind assistance, and the valuation information which I received from the Reclamation Service.

According to your advice, I have made several inspections in the Western States on the following project: Denver, Grand Valley, Strawberry, Minidoka, Boise, Umatilla, Salt River, and Rio Grande.

I wish also to express, on behalf of the Argentine Reclamation Service, its great appreciation and sincere thanks for the courteous and kind assistance which the representatives of your Reclamation Service rendered me while inspecting the above-mentioned project.

I am very satisfied with my investigations, and I believe that your wonderful experience in this branch of human activities will be of great interest to my country, and I hope that this intellectual exchange will mean a greater understanding, and a better friendship between the two sister Republics.

Respectfully, yours,

CARLOS A. VOLPI.

A SUCCESSFUL WATER USER.

Frank M. Kerr, Lower Yellowstone Project, Montana-North Dakota.

During the past five years, in spite of all kinds of climatic conditions, I have grown corn, and what I have accomplished on one of the poorest units in the valley anyone can do by practicing modern systems of farming.

The most important item is acclimated seed properly cared for until needed. I would rather pay $5 per bushel for seed raised in this locality than have eastern-grown seed laid down at my farm free of charge. Upon repeated tests by myself and the State agricultural college at Bozeman the germination from about 75 bushels of seed corn I raised last year was 100 per cent.

From my experience the best time to plant corn is between the 15th and 20th of May.

I use a surface cultivator, not to kill weeds but to keep them from starting and always keep a dust mulch.

Last year my corn yielded 62¼ bushels per acre. This was Minnesota Thirteen.

I seldom irrigate corn more than once. In addition to the corn and the increase in the yield of grain crops the following year there is the roughage for feed, which, in my judgment, makes corn one of our most valuable crops. My success with corn dates back a good many years when "dad" convinced me of the proper method of cultivating all crops.

You are publishing a splendid magazine, and we hear much good comment concerning it.—*F. C. Henshaw, Secretary, Salt River Valley Water Users' Association, Phoenix, Ariz.*

A look back at the legal and business happenings

GRAND COULEE DAM Born of Tribulation

by SPENCER BAIRD of Coronado, Calif.

AS ONE admires the eighth wonder of the world, the Grand Coulee Dam and powerplant, he is naturally impressed by this monolith of cement and steel and he knows that even greater than those materials, is the intelligence that directed their orderly placement.

However, the casual observer likely does not sense the political and legal—and engineering questions that are buried in the structure. But they are there, and are at least as real as the materials of which the dam is constructed. (It was constructed from 1933 to 1942.)

The project was born of our worst depression, went through great tribulations of doubt and fear, and was caught in the merciless crossfire between the advocates of "public" and "private" power.

It almost died abornin' when the prospect of a low dam threatened to preempt the high dam and the ultimate development of the project's potential.

In that economic depression, banks were closed, private industry was on dead center, and there was scarcely a market for anything. As a relief measure the Federal Government provided so-called "leaf-raking" projects. Former lumber barons were peddling apples on the street corners and competent engineers were adding up columns of figures for a meager dole with which to meet the most urgent needs of their families.

Clearing bedrock for the start of Grand Coulee Dam, July 1935.

Three Billion Dollars Provided

Three billion dollars were appropriated by Congress to be allocated by the Public Works Authority, among the States for the emergent construction of public works to give employment. Surveys of the Columbia River Basin had been in progress by the engineers of the Bureau of Recla-

Considerable work was done at this point, but much was remaining.

mation and the Army Corps, and were almost completed.

A dam site, thoroughly tested by nature many centuries before, was available, and an allocation made by the PWA to the State of Washington, was also available, but limited to some $70 million, which was estimated as adequate for the construction of a low dam only.

It was the opinion of the layman, shared by some prominent engineers that a low dam could be constructed and progressively enlarged, as an expected growing demand for electric energy should require.

Engineers of the Bureau of Reclamation, faced with the alternative of construction of no dam, or a low dam with the money available, prepared plans and specifications for a low dam.

These specifications included a provision that at the Government's option, an order for change might be given to the contractor, changing the work to be performed from construction of a low dam, to the construction of a foundation for the high dam. So both were included in the general plans for the low dam.

High or Low Dam

Specialists for the Bureau of Reclamation worked with "tongue in cheek." They did not want to construct a low dam, because it would end all prospects for full development of the river. It was not feasible from an engineering standpoint to construct a low dam, and make progressive additions to it.

They so testified in the condemnation action to acquire private lands in the dam site. That action turned upon such testimony, in favor of the Government's position.

The contract for the low dam was let, and scarcely before ink in the contract signatures had dried, the order for change was issued, changing the contract's work to a foundation for the high dam. So as not to leave Reclamation with "tongue in cheek," we pause to pay them tribute. They demonstrated intelligence, integrity, and courage, except for which we might now be viewing a low dam in the bed of the river, usurping the throne of the Grand Coulee Dam and powerplant, with its current construction of the Third Powerplant.

The present structure tells its own story of the completion by a second contractor of the superstructure upon the foundation constructed by the first contractor.

If any single political factor moved the construction of this project it was the reaction to hunger brought about by a devastating depression.

There Was Criticism

There was, however, another political factor, such as underlies all such government projects namely, "public opinion." There was, of course, criticism both for and against the project.

Much of that against it was wholly arbitrary, but some was in good faith. For example, some doubted its economic feasibility, because of an extremely limited market for the tremendous block of power the project was capable of developing.

This doubt was, to some extent shared by the engineers conducting the investigations for the Columbia Basin development.

A review of their reports will disclose that a thorough and frantic study was made to determine all possible uses for the power capable of being generated, and of the means of enlarging and developing markets for its use. Here, the irony of war was manifested.

Before the first turbine and generator could be completed, the United States became involved in World War II, with the result that the demands for power literally exploded, and as the several units were completed, their output was switched onto transmission lines, and they were operated at full capacity—some greatly in excess of their rated capacity, to supply the apparent insatiable demand for power.

An important phase of the project should be noted. It does not come to folded hands. To lead the general consensus of thought to a worthy object, requires "hard hats," rolled up sleeves, and the smell of sweat-hard work for which there is no synthetic. This is "dedication."

Had the opponents of the project worked as hard as the proponents—the O'Sullivans, the Rufus Woods, and the Billy Clapps, and many others like them, this might have been a different story.

Like Ezekiel

The destructive and constructive critics of the project must have had thoughts like the prophet Ezekiel when he wrote:

"Son of man, what is that proverb that ye have in the land of Israel saying—

"The days are prolonged and every vision faileth.

"Tell them therefore thus saith the Lord God, I will make this proverb to cease, and they shall no more use it as a proverb in Israel; But say unto them, the day is at hand, and the effect of every vision."

If by chance you should meet someone coming out of a courtroom, muttering disappointments, you might ask in a friendly way: "What's the matter my friend?"

He would probably snarl: "I was robbed!" thus identifying himself as a defendant in a condemnation suit.

If—and only if—he cocked a fishy eye at you and grunted: "Why?" You might explain that if he lived in England during the reign of the Tudors, the King would have taken his land without paying a cent, or better, "twopence," and no questions asked—by the King's subject that is.

Condemnation or an exercise of the power of eminent domain in England, was adopted by the United States but "Americanized" to condition an exercise of its power to payment to the private owner of the lands involved a just and reasonable compensation therefore.

Tracts of Land

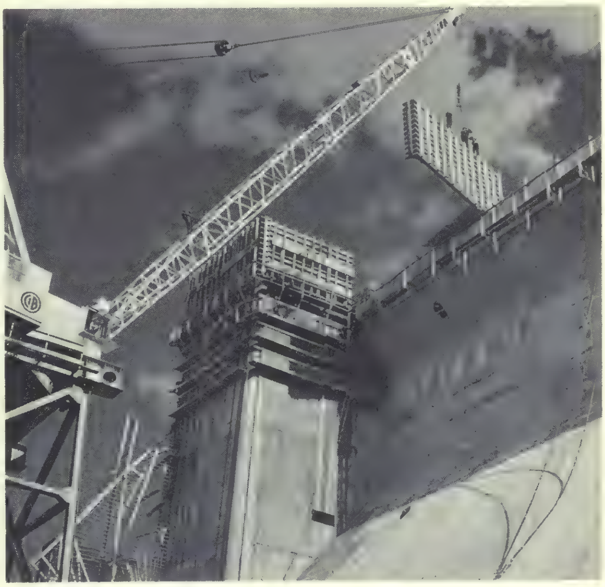
For use in its Grand Coulee Dam and powerplant project, the government was required to condemn two tracts of privately owned lands: one, the tract upon which the dam and powerplant now stand and the other, a tract known as the "Brett Gravel Pit."

Both tracts were invaluable for the project, principally because of their location. The Continental Land Co. lands constituted the dam site. The Brett lands were so situated that sand and gravel could be mined, screened, and graded, and carried almost by gravity, by converyor belt, to the concrete batching plant, located at the right abutment of the dam.

There were large quantities of suitable sand and gravel everywhere. Deposits, greatly in excess of any possible demands, were made in the reservoir formed by glacerial action centuries before.

The admission of the principal value of these tracts, is because of their locations, naturally raises

This is work on the elevator tower. Photo taken in June 1941.



Partial use also was being made of the dam when seen in 1941.

the question in the minds of the layman, as to why the private landowner may not receive as reasonable compensation therefore, their value to the United States for its project.

Land Compensation

The rule is well established by our courts, that the owner of private lands being taken by a sovereign for public use, may not claim as just and reasonable compensation the value of such lands for the project under construction. The reason for this rule is self-evident, in that without it no public works could be constructed.

The owners of the lands condemned were entitled to show their value not only for their existing use as grazing and agricultural purposes, but for any additional use or uses for which they could be adapted. For example obviously, the lands had no value as sites for high-rise apartments.

However, in the case against the Continental Land Co., notwithstanding the government was condemning for dam and powerplant site purposes the defendant was not precluded for showing as a reasonable use of its lands, that by private capital it could construct thereon a dam and powerplant for the generation of electrical energy for commercial sale.

Such a claim was made, which measured in dollars and cents, amounted to approximately $3 million.

The defendant first attempted to show that it could construct a high dam and powerplant, but failed to show such was a reasonable use of its lands. Because, by the time a market could be developed for the power output of the plant, the excess of interest on the investment over revenues from the sale of electric energy, would have long since "eaten up" the principal of the capital investment.

Add To Height

The defendant then attempted to show that by use of private capital, it could construct a low dam and powerplant with an output equal to the then market demand, and as the market expanded, add to the height of the dam, and increase the power output accordingly.

A consulting engineer from Buffalo, N.Y., testified it was economically feasible to do so.

However, the testimony given by the government engineers, established that such a plan was infeasible from an engineering standpoint.

The reason given, as a layman might understand it, is because concrete at different stages of cooling, or "curing" assumes widely different characteristics. To attempt to add height to a low dam, and establish a proper bond between the new and old concrete would develop stresses along the plane of contact. This would result in excessive leakage, if nothing worse. The court adopted the government's contention, and awarded as just and reasonable compensation, the value of such lands, used for stock grazing and farming purposes only.

In the suit condemning the Brett gravel pit, the attempt was made to show in the courts that there was a local market for sand and gravel such as would give the lands a higher value than for grazing and agricultural purposes.

Judgments on this matter were appealed to the circuit court of appeals, where the trial court's awards were confirmed.

On further appeal to the U.S. Supreme Court, the ruling of the circuit court was affirmed.

Railroad Racing

If horse racing was the sport of kings, railroad racing was the sport of the money barons of Wall Street. Interest in that sport began when development of the steam engine reached a relatively practical state of perfection, and ended only when the United States became gridded with paralleling and crisscrossing railroad tracks.

During the interim, the "Jim Hills" and the Harrimans" were cracking whips over the backs f rival construction gangs of coolie laborers, hrusting dual rapiers of steel into the ever-retreating West, over what was then called "The Great merican Desert." The iron horse was closely folwing—if not pushing—the construction gang.

The sport was revived in the early 1930's, when banner news story broke carrying announcements y two of the major railroads of the Pacific Northest of their intention to construct branch lines om the Grand Coulee Dam construction area to eir respective nearest station.

Periodic bulletins were issued from rival camps nnouncing new plans which would assure that eir branch line would be completed first.

As the Grand Coulee Dam site was relatively olated, a branch railroad was essential to the roject's needs. Heavy machinery and equipment, nd many of the materials required could be rought in only by rail.

rucks Competing

The trucking industry was only then entering to serious competition with the railroads, and uck haul was limited by inadequate highways nd lack of necessary equipment.

For example, the 11,800,000 barrels of cement sed in the project was procured from some five ment mills, which had no facilities for loading ulk cement into trucks. Also the cement mill's rice on bulk cement was in most cases directly reted to published railroad tariffs.

In the story of the race between the tortoise and the hare, one of the participants—the hare—took a nap, allowing the turtle to crawl first across the finish line, but in this railroad race, both contestants took a nap, and neither ever reached the goal.

The race was continued in the newspapers until the needs of the Government for a branch railroad became acute. Then both the contesting railroads announced that neither of them would constrict a branch line to the dam site.

Railroad Built

A branch line was constructed—as you may have guessed—by the United States, connecting with the Northern Pacific at its Odair station near Coulee City. Thus, the Government was committed for rail haul of project materials to the railroad site where its branch line made connection.

The records and files of the railroad companies involved are, of course, not available for inspection, and we are left to conjecture and speculation as to how the two railroads became involved in this race, and why it was so abruptly ended.

Even in our speculations, we are not given to imputing anything but the best of motives for the actions of the executive officers of the two railroads.

Hence, we assume that the race was entered into in good faith. That there was not compromise nor collusion involved in the abrupt termination of the race, but rather, plans for such branch line construction were abandoned, because in the

Its nearby environment emphasizes the beauty of Grand Coulee Dam.

(Continued from article: "Grand Coulee Dam Born of Tribulation," page 23.)
judgment of the railroads' executives, such an undertaking would not be in the best interests of the companies.

To arrive at that conclusion resort may have been had to railroad lore, which has it that Mr. Harriman of Union Pacific fame once remarked that he would authorize the construction of a branch line to a haystack, but not to a mine.

# # #

(Our appreciation goes to the author Mr. Baird for this article, and to the Wenatchee Daily World newspaper where it first appeared in series last April. Mr. Baird was an attorney for the Bureau of Reclamation during construction of the dam.)

NEWS NOTES

Bureau Power Served East Coast

Power generated at Reclamation hydro powerplants is used on a day-to-day basis in the West, and is available through interconnections for emergency power conditions to non-Reclamation areas of the Nation. Such emergency use during an unseasonal heat wave was demonstrated on September 22, 23, and 24, 1970, when a number of large generators in New York and other East Coast areas failed or were in maintenance status. Providing some 200 megawatts of power, by displacement, from the Missouri River Basin project facilities, the Bureau helped to alleviate some of the essential power needs in the East and as far south as the Carolinas.

Two hundred megawatts also were directed on November 17 to the Chicago area while repairs were being made on a damaged tower in a power corridor serving that city.

Environmental Criteria For Electric Utility Planning

A new 52-page booklet entitled "Environmental Criteria for Electric Transmission Systems" has been issued jointly by the Department of the Interior and the Department of Agriculture.

The publication is intended to serve as a guide in the planning of needed electric transmission systems, and all agencies of the two Departments have been directed to use the criteria in planning and reviewing transmission line projects.

In a foreword, the Secretaries of the Interior and Agriculture called application of the criteria "* * * a step that can be taken now to restore harmony between man and his surroundings. All government agencies, the electric utility industry and private organizations to adopt the criteria in an effort to assure adequate environmental planning."

The publication is available for 65¢ from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Its catalogue number is I 1.77/2:EN 8. It is not available from the Dpartment of Interior or the Department of Agriculture.

Cloud-Seeding Study In Texas

The Bureau of Reclamation awarded a feasibility study contract to the Institute for Storm Research at the University of St. Thomas, Houston, Tex., which will provide basic data for development of a long-range summer cloud-seeding program for a five-county area of west Texas.

Goal of the long-range program, which was conducted last October, would be to augment precipitation in Green, Irion, Reagan, Upton, and Schleicher Counties and stimulate runoff of the Concho River above Twin Buttes Reservoir, a Bureau of Reclamation facility.

Successful Cloud Program in Montana

Cloud-seeding which has increased the snowpack in the Hungry Horse Basin of western Montana an average of 10 percent over the past 4 years is being conducted again this winter.

The Bonneville Power Administration has stated that a 10-percent increase in the storage in Reclamation's Hungry Horse Reservoir will generate power worth $3 million annually at Hungry Horse and at downstream Federal and non-Federal hydroelectric projects.

Assuming that the recorded snowpack increase produces the same increase in reservoir storage, the result of the 4-year operation has been worth $12 million in generated power and the program cost has been only $286,000.

U.S. GOVERNMENT PRINTING OFFICE:1971 O—412-679

MAJOR RECENT CONTRACT AWARDS

pec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
6812	Columbia Basin, Wash	Oct. 14	Furnishing and delivering the 525-KV power transformers and 420-KV lightning arresters and spare parts for Grand Coulee Third Power plant.	Brown Boveri Corp., North Brunswick, N.J.	$2,727,680
6841	Colorado River Storage, Wyo.	Oct. 15	Stages 02 and 03 additions to Archer Sub-station, Transmission Division.	Flora Engineering Co., Denver, Colo.	219,132
6846	Columbia Basin, Wash	Oct. 20	Furnishing and installing two 67,500-hp/50,000-KVA motor-generators, Grand Coulee Pumping Plant.	Westinghouse Electric Corp, Denver, Colo.	2,029,672
6847	Columbia Basin, Wash	Oct. 29	Generator-voltage isolated-phase bus structures—Grand Coulee Third Powerplant.	H. K. Porter, Inc., Chicago, Ill	504,582
6849	Navajo Indian Irrigation, N. Mex	Oct. 23	Construction of Main Canal and Tunnels 3 and 3A, appurtenant structures and concrete canal lining.	Fluor Utah Engineers & Constructors, Inc., Burlingame, Calif.	8,681,188
6850	Missouri River Basin, S. Dak.	Oct. 15	Stage 12 and 13 additions to Watertown Sub-station, Transmission Division.	Kehne Electric Co., St. Paul, Minn.	426,028
6853	Columbia River Basin, Wash.	Oct. 28	Construction of Stage 02 additions to Grand Coulee 230-KV switchyard.	Christenson Electric, Inc., Portland, Oreg.	423,759
6854	Central Utah, Utah	Oct. 19	Construction of Soldier Creek Dam and East Side Access Road, Bonneville Unit.	Burgess Construction, Fairbanks, Alaska.	9,873,924
6855	Central Utah, Utah	Nov. 18	Construction of Strawberry Aqueduct, Currant and Layout Tunnels, Diversions and Appurtenant Structures.	S. A. Healy Co., McCook, Ill.	10,971,025
6856	Columbia Basin, Wash	Nov. 19	Armature Windings for Generator Units G–2 and G–3 at at Grand Coulee Left Powerplant.	Westinghouse Electric Corp., Denver, Colo.	544,580
6857	Columbia Basin, Wash	Dec. 14	For furnishing, delivering complete, and placing in final location the 230-Kilovolt power transformer with high-voltage, oil-filled terminal tank, and furnishing and delivering spare parts, for Grand Coulee Pumping Plant.	Societa Naz. le Officine di Savigliano, Turin, Italy.	312,025
6859	Central Valley, Calif	Nov. 30	Construction of San Luis Canal, Station 3134+00 to Station 3570+00, Canal Bank and Lining Modifications, San Luis Unit.	Oscar C. Holmes, Inc., and Holmes-Clair, Inc., Menlo Park, Calif.	709,905
–38,449-A	Columbia Basin, Wash	Oct. 9	Governors for units P/G 7 and P/G 8 Grand Coulee Pumping Plant.	Woodward Governor Co., Rockford, Ill.	142,310
–1120	Columbia Basin, Wash	Nov. 5	D46–24 Drain System Extension, Block 46	John M. Keltch, Inc., Pasco, Wash.	194,886
–1124	Columbia Basin, Wash	Nov. 5	D72–317 and D72–361 Drain System, Block 72	Equipco Contractors, Inc., Ephrata, Wash.	141,261
–1128	Columbia Basin, Wash	Dec. 14	For Supplemental Construction, Blocks 13, 14, 16, 161, 17, 19, 20, and 23.	Burke Construction Co., Pasco, Wash.	113,969
–1131	Columbia Basin, Wash	Nov. 5	Drains—D19–157 Extensions and D20–239 Systems, Block 20.	J B & C Company, Scottsdale, Ariz.	138,912
–1136	Columbia Basin, Wash	Nov. 5	Ringold Wasteway Alternate, Blocks 15 and 19	Tony Russell Construction, Inc., Ketchum, Idaho.	143,681
–811	Central Valley, Calif	Oct. 8	Clearing Auburn Damsite, Auburn-Folsom South Unit	Mastelotto, Inc., Arvin, Calif.	120,817
–294	Delivery of Water to Mexico, Ariz.	Oct. 26	Modification of Wasteways, Reconstruction of West Main Canal, Station 1170+00 to Station 1348+00, Relocation of Cooper Lateral Wasteway.	Arrow Construction Co. of Arizona, Inc., Yuma, Ariz.	144,661
–818	Central Valley, Calif	Dec. 29	Completion of roadway for temporary service facilities Auburn Dam.	Pacific Excavators, Albany, Calif.	117,257
–1139	Vale, Calif	Dec. 29	Earthwork and concrete lining for repairs to Vale Main Canal.	E. W. Eldridge, Inc., Sandy, Oreg.	295,520

lden Eagle Returns

The Golden Eagle passport is now on sale for 71 at $10—$3 more than in past years.

The Golden Eagle passport is still a bargain r people who make several visits each year to deral recreation areas. It facilitates entrance o park and forest areas and can be used witht limit to the number of visits or the number of rsons in a single private vehicle. Daily entrance s may be paid instead, if desired.

Some popular recreation facilities which the ureau of Reclamation built around its reservoirs e among those which passport holders often visit.

The passport is an annual permit for use at iblic outdoor recreation areas operated by the ational Park Service, Bureau of Sport Fishies and Wildlife, Bureau of Land Management, d Forest Service, Department of Agriculture. some areas there are additional user fees for mping and other activities.

Symposium on Shrubs in July

An international symposium on useful shrubs of the world's dry lands will be held at Utah State University, next July 12 to 17.

Proceedings will be published. For further information or to make reservations write: Dr. C. M. McKell, Head, Dept. of Range Science, College of Natural Resources, Utah State University, Logan, Utah 84321, U.S.A.

River Man's Papers To Archives

The papers of one of America's leading "river tamers," the late Sinclair O. Harper, have been presented to the Western History research center of the University of Wyoming library.

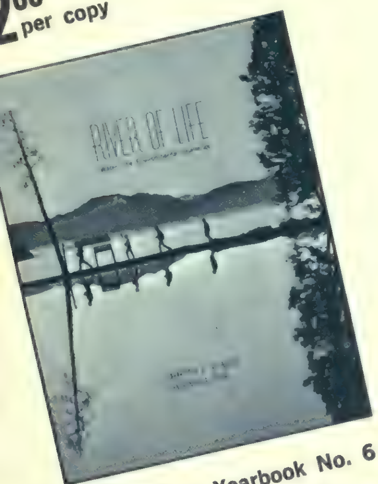
Harper, often called a "river doctor," achieved international prominence during his 37½ years with the Bureau of Reclamation, and 20 years as a private consultant on water resources. He died May 25, 1966, at age 82.

UNITED STATES
GOVERNMENT PRINTING OFFICE
PUBLIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

2^{00} per copy



Conservation Yearbook No. 6
CATALOG NO. 11.95:6

River of Life

WATER: THE ENVIRONMENTAL CHALLENGE

Of all the links in the environmental chain of life, water is one of the most vital. Mankind's very existence depends on this critical resource. Water is the river of all life on this planet, as it has been since the beginning of time. Althoug the presence of man on earth does not affect the planet's total water supply man has affected the quality and availability of water at an ever increasing rate.

This first Environmental Report in the Department of Interior Conservation Yearbook series portrays the story of water in vivid natural color, from crysta clear dew-drops to oil-stained oceans.

The Department reports its progress in the regulation, research, wise use and cleansing of the environmental life substance . . . WATER.

The Conservation Yearbooks are all printed in vivid natural full color, big 9" b 12" page size with hundreds of beautiful pictures.

AIL ORDER FORM To:

perintendent of Documents, Government Printing Office, Washington, D.C. 20402

closed find $................ (check, money order, or Supt. of Documents coupons). Please send me .... pies of

ease charge this order my Deposit Account
. ...

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DOCS
----Enclosed----------
----To be mailed later----------
----Subscription----------
Refund----------
Coupon refund----------
Postage----------

FOR PROMPT SHIPMENT, PLEASE PRINT OR TYPE ADDRESS ON LABEL BELOW INCLUDING YOUR ZIP CODE

U.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

Name ....

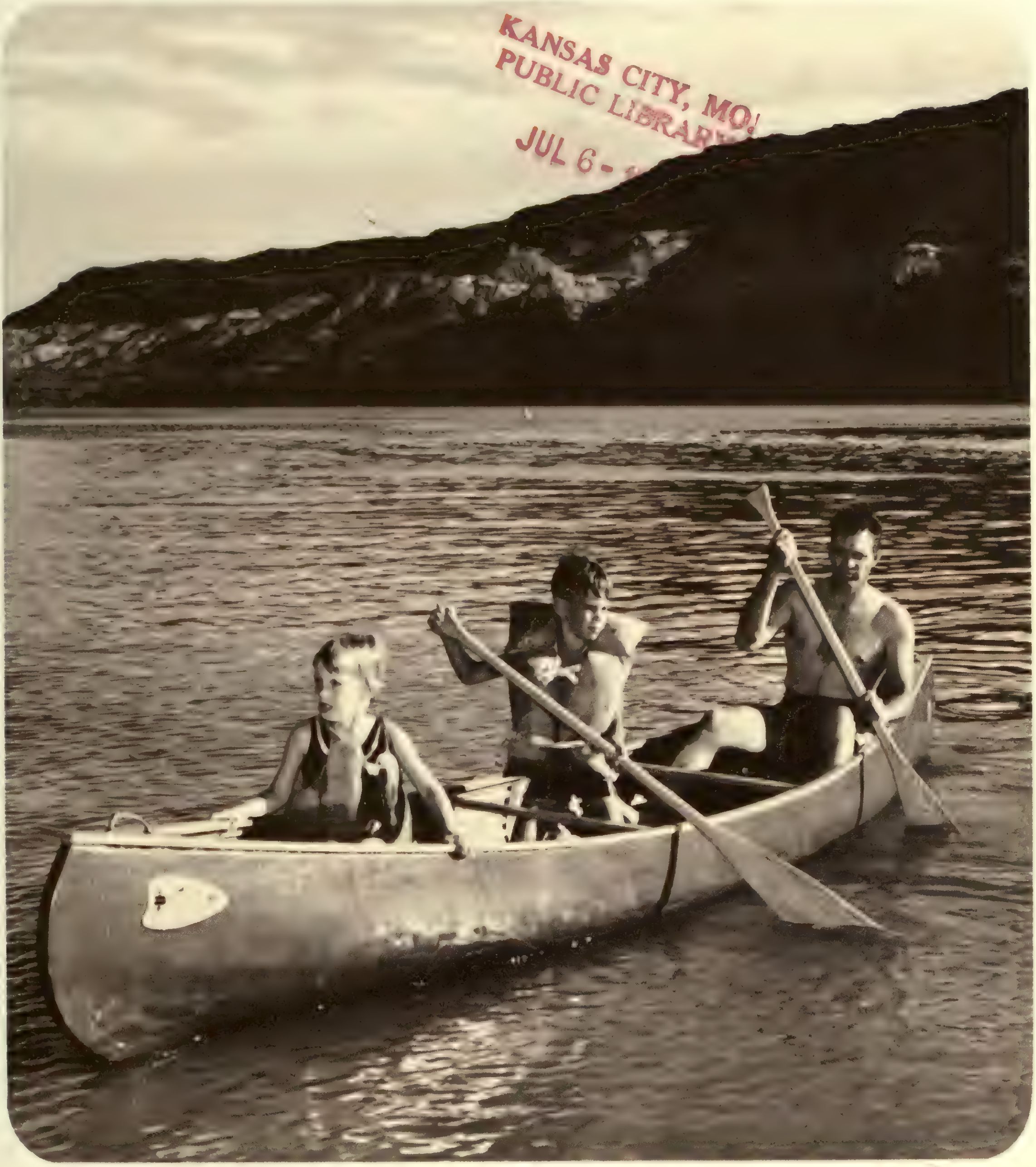
Street address ....

City and State .... ZIP Code ....

May 1971

RECLAMATION era

A WATER REVIEW QUARTERLY



May 1971 • Vol. 57, No. 2

RECLAMATION

era

Gordon J. Forsyth, Editor

CONTENTS

COVER. "We love the lake," said canoeist Ed Rauchfuss shown with his son Jimmy and a guest. They are on Bighorn Lake in the Horseshoe Bend area of Wyoming. Ed made the canoe at his home in Powell, Wyo. (See area story on page 11.)

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAG

Let's Carry Our Share

President Richard Nixon has presented two me ingful proposals for protection and management of Nation's natural resources and the environment.

The emphasis of the President's messages refle the concern of people across the country about the envir mental protection needed to keep man from destroyi himself. He stated that the citizenry must become fu informed so they can help make decisions and take atíve action today and in the future on environmen problems which confront us all.

To enhance the environment—including its mu ple relationships with ecology and man's needs—is familiar field of endeavor for the Bureau of Reclamati

We have had many years experience at balanci the multiple purposes of important water resources pr ects. These water projects have dramatically turr unruly creatures of nature—rivers—into giants of usef ness and opportunity for man. Reclamation projects res in water and power for community, industrial and ru uses, for recreation, and for fish and wildlife enhanceme

Other critical, but less obvious, areas of envir mental concern also are becoming a vital part of Reclamation program. A few such problems related to project areas are: Disposal and reuse of waste materia pollution of air, water, and noise; pesticide poisoning fishes and wildlife; aquatic weed and algae control; d control; seepage; and socio-political impact of manm facilities. These problems are not exclusively ours; th are common to man's impact on nature, and they national and even global in extent.

To give this broader program the attention it w rants, we now have a full-time staff of ecologists to co all our activities.

These scientists have the responsibility to ident and cooperate in solving all related problems of nat encountered within the Bureau. It is a big job. No knows how soon all the difficulties will be solved, but shall do our share.

We are confident the applied efforts will bring answers, and will help provide enjoyable living in bala with nature, which is being demanded by people eve where.

Ellis L. Armstrong
Commissioner of Reclamat

Surfers about to plungs for a big ride to the beach.

A new sport in the desert

ARIZONA'S SURF OCEAN

by EUGENE E. HERTZOG
Head Regional Photographer
Boulder City, Nev.

SURFING, a sport once confined to ocean beaches, has come to the desert.

To the delight of many who live in the heart of Arizona's desert, the majestic roll of the surf provides thrills and a sandy beach as does the sea.

The surfing facility includes a 2½-acre lagoon holding 4 million gallons of treated water located in the city of Tempe. It is reportedly the world's first authentic inland surfing operation.

Surrounding the lagoon is 4 acres of beach, which perhaps is as important to the visitors as the surf waves. The water is 9 feet deep at its deepest point.

An attractive 1-acre mall includes palm trees, colorful polynesian type shade buildings, food service, and bath houses. The facility is lighted for night operation, and is open for business during spring, summer, and fall.

Big Surf, Inc., an Arizona corporation in the surf business, was underwritten by an out-of-State firm at a cost of 2.4 million.

Water for the surfing facility is from the Salt River Project marketed through the city of Tempe. Authorized in 1903, the Salt River Project was one of the Bureau of Reclamation's first large multipurpose water resource projects.

Phillip Dexter of Phoenix, Ariz., invented the wave generation process used at Big Surf. Dexter's first experimental model, completed in 1966, was of plywood held together with bailing wire and discarded socks.

Subsequent models were more exacting.

Waves at Big Surf's full-scale operation are produced through a custom hydraulic system housed in a 160-foot-long reservoir resembling a wall at one side of the lagoon. Water is pumped to a prearranged height in the wall and held by underwater gates. When the 90,000-gallon supply of water is released it breaks over the baffle, or "breaker," adjacent to the wall and makes waves 3 to 5 feet high.

Then, similar to surf at Waikiki Beach, Hawaii, the surging waves move toward the sandy sides of the lagoon. Surf releases are made every 45 to 60 seconds.

3- to 5-foot waves produce a convincing ride about once a minute.

Wave height can be varied, producing big waves for accomplished surfers or smaller ones for those who prefer rubber-raft riding and surf bathing. For those even less athletic, there are always sun bathing and surf watching.

First opening to the public in October 1969, plans are underway now for the water to be heated during the cooler months. # # #

The 2 1/2-acre lagoon is featured in the 20-acre Big Surf complex.

Helpful answers on some problems

ENVIRONMENT AND ECOLOGY AT SMALL DAMS

by ELWOOD A. SEAMAN
Assistant to the Commissioner—Ecology

ENVIRONMENT—the total relationship of land, water, air, other earth resources and people—as related to design of small dams, is a consideration of ecologists now at work in the Bureau of Reclamation.

Efforts of the ecologists are directed not only to the immediate environs around the dams, but also to the shorelines downstream and upstream from dams. Their concern is for water temperature variations, dissolved gases, sediment loads, streambed configurations, fish migration, and shoreline environment.

The term *ecological* sometimes is misused, or substituted for the word *environmental*. Ecology refers to a branch of biology dealing with relations between organisms and their environment. Environment is the sum total, or aggregate of things which surround the organism and affect its existence or development.

Therefore, t o t a l environmental/ecological awareness is a relatively new field, and a new concern for water resources planners, builders, and operators.

The attitude of some professional persons in related environmental sciences, as well as some concerned members of the public at large, is that of opposing the building of dams. This is particularly true if there has not been sufficient consideration of the total affect the structure will have on the environment.

Until recently environmental compatibility has been secondary to the economic consideration at many dams in America.

Full Partner

The environmental consideration's may now be viewed as a full partner to the economic aspects because of recent legal and policy commitments, and because of rising public interest in the preservation and enhancement of the environment.

A small dam constructed across a natural stream can provide vital stream control for man's benefit, but it also can create specific impacts on the environment of an area with many subtle but serious ecological affects. Consideration of measures to correct deficiencies and to enhance the total environment are a must in this day and age.

The matter of enhancing the total environment—and its multiple considerations—will be an unfamiliar activity for some builders of manmade structures. The Bureau of Reclamation which has

Some forest debris left in a reservoir area, such as the logs at right, may enhance fish habitat. Water from this North Fork high mountain lake eventually joins the Arkansas River at Salida, Colo., where a Reclamation water project will bring many benefits.

the experience of building scores of multi-purpose water resource projects, is taking a leading role to broaden its concepts to cover the environmental thinking of today.

Impounded water is utilized for industrial and domestic water supplies, irrigation, water quality improvement, electric power generation, fire protection and flood control. Such uses are determined by the specific authority applicable to each development.

In addition, lakes or reservoirs of any size created by dams are almost always used for public outdoor recreation (fishing, hunting, boating, skiing, swimming, scuba diving, picnicking, and camping) and fish and wildlife management.

Multiple uses are properly considered in the planning of small dams and reservoirs although probably not to the degree of larger projects.

To Accommodate Many

To accommodate many interests and uses of the water structures, certain compromises are necessary. To cite one example, perhaps not all demands for all the various types of recreation can be met at one reservoir, especially if it is a small reservoir.

Nevertheless, some specific adjustments usually can be made in the dam design or construction to meet recreational needs.

The best time to consider the total environmental impact and necessary adjustments is in the planning and design stages of dams and reservoirs. It is advisable to hold consultation conferences with the proper agencies to discuss design ideas and needs for all phases in detail.

Water Temperature

Some of the more common environmental concerns are in water temperature variations. Impoundments at depths greater than 50 feet (large-dam category), may have colder water temperatures in the lower strata which are undesirable to fish life downstream. Multilevel release gates may be used to regulate downstream temperatures. There are circumstances, even in many small reser-

voirs, where similar conditions exist and water temperatures can be adapted to downstream needs by careful planning.

The shallow water areas in a small reservoir may be sun-warmed during summer months to such a degree that, upon release, the temperature of the surface water may be unsuitable to cold-water species of fish. Therefore, one or more outlets below middepth of the dam may be included in the design to permit release of cooler waters when required.

On the other hand, if there is a principal requirement to develop a warm-water fishery, surface or near surface releases may be desired.

Reservoir Fluctuation

Among the most significant environmental problems of our time is how we use our water.

In most instances, regulated water releases from small dams in times of normal and even above normal inflow improve quality and quantity downstream.

Runoff from lands adjacent to the reservoir often cause excesses of nutrient inflow and such inflow can cause algae blooms in the reservoir.

Examples of nutrient inflow are wastes from cattle feed lots, heavily fertilized fields, and drainage from waste treatment plants. Inadequately treated community wastes can also add to nutrient and biological problems.

Reservoirs can often be regulated to benefit a fishery or waterfowl population when the biological and ecological aspects of the wildlife populations are known.

Water releases downstream also affect various forms of wildlife and recreation use. These aspects should all be considered in the planning and operation stages.

Construction Activities

Another category important to how a reservoir will look when completed results from the construction practices. Open landscape scars often are caused by borrow pits, or improperly placed roads which cause erosion from extreme banks and cuts.

Borrow pits should be located as much as possible in areas not readily visible to the visitor at the dam or reservoir, preferably in the reservoir area itself. If this is not possible, they can be dressed up in several ways.

Unattractive or steep slopes can be changed to more pleasant appearing ones, and vegetation can be planted to screen off the undesirable aspects. Borrow pits sometimes can be used as fish ponds, or, if shallow, for waterfowl. If they are used for waterfowl, edges should be gradually sloped and topsoil should be placed on the slopes to encourage growth of aquatic plants and aquatic invertebrates.

Because of erosion, access roads should be carefully planned and designed for a minimum amount of soil cutting. All travel prior to, during, and after construction should be confined to these roads as much as possible.

Many times the construction road will be utilized for recreation access. A well-planned road in the beginning may be converted and eliminate the need for building another road.

This shows a fish guide rack across the American River, in Calif. There is much tourist interest in the Nimbus fish hatchery complex, located mostly at right out of the photograph. Steps down the river bank and the fish ladder also are shown on the shore.

Revegetate

Revegetation as cover of construction scars, where appropriate, should take place as soon as possible.

Use of annual grasses native to the area, preferably, small grains or sod make a quick cover in most areas of the country. Mulch, burlap, plastic sheeting, or straw-tar mixtures protect the soil while the vegetation is starting to grow.

Trash from construction activity should not be left on the property. Provisions for removing it, and for collection and removal of trash and litter deposited by reservoir users, should be established prior to creation of the impoundment.

lake appearance at the shoreline, thereby enhancing the beauty.

Blending manmade structures into the natural surroundings prevents a dam from becoming an eyesore. One way this can be accomplished is by using riprap (rocks) of the texture and color of rocks in the surrounding scenery. The source of the riprap, however, usually should not be in the immediate view of people who will visit the dam.

Care should be taken to avoid destruction of native vegetation which would normally remain after construction activities. This is particularly important in arid or alpine areas where vegetation is sparse and difficult to replace. These plants not

Visitors are seen at left enjoying the Nimbus fish ladder operation. Right, A fish ladder (PG & E Co.) for fish to go around a dam in Oregon.

Some soil erosion is inevitable during periods of construction, and ways should be utilized to keep the erosion to a minimum.

If the construction activities are not carefully handled, the resulting sediment can be excessive and can cause severe damage in the reservoir or in the stream below the dam.

Different Designs

Aesthetic appearances of dams have usually been based on economics. Although many older dams are aesthetically pleasing there is a trend today to break away from some of the traditional designs.

For instance a concrete or earthen dam which gives a slightly curved shoreline appearance is thought to provide a reservoir with a more natural

only help the area look better but are also an important part of the ecosystem in that area.

Clearing such vegetation as forest debris from the reservoir area has been a common practice. Burning all such material often is replaced nowadays. In cases where burning is not appropriate or permitted, grinding, chipping, or rotting down the trees have been undertaken.

In any event, total clearing of a reservoir area is not always necessary. Fish and Game Departments in some States request that specific volumes of trees or tree debris be left standing in certain parts of the rservoir to provide better habitat for certain species of reservoir fish such as bass and crappies. The areas usually are zoned to protect the boating public from such hazards.

On older reservoirs brush piles are sometimes used for this purpose. The brush is staked down

Hotchkiss fish hatchery, producing trout for reservoirs of Reclamation's Colorado River Storage project, is at the North Fork of the Gunnison River, a scenic mountain area near Hotchkiss, Colo.

during a low-water period to prevent it from washing toward the dam when the reservoir fills again.

Other Ecological Considerations Are:

1. Fish populations in the stream should be studied and a decision made as to whether the same or different populations would be successful in the reservoir.

2. How might the fishing be enhanced, and what can be done to mitigate any possible damage to fish populations by nature or project facilities?

3. What will be necessary to enhance the wildlife population, and to reduce possible losses to it?

4. What are the plant species in the area, and can they be improved or replaced if necessary?

5. What is the long-term flow record in the stream, and what can be done to get the most from it for benefit of man, fish, wildlife, and plants?

6. If there is danger of fish kills in the waters due to ice and snow, what adjustments can be made to eliminate the problems?

7. What types of recreation facilities are needed in the area, and how much adjustment for recreation should be made at the new site?

8. Is consideration being given to historical and archeological sites near or in the reservoir area?

9. Is complete consideration being planned for the present and potential land use by man, animal, and plant life in both the upstream and downstream areas?

10. What are the soil types in and around the area which might affect man's activities, animal and plant life, or the quality of water?

11. What are the possible problems and solutions associated with mosquitoes or other insects?

12. Is a place provided to catch and hold fish from the reservoir if that facility would have to be drawn down for any reason?

13. Is there a need for fish ladders, screens, or other devices on the dam, canals, or other project features?

14. Is consideration given to meet problems of noise or air pollution or individual safety during periods of construction and for the various operational uses of the facilities?

There are many other environmental factors which should be studied early in the planning of a proposed dam and reservoir to bring maximum benefit to man and his environment. All concerned groups of persons should be fully informed and consulted during the planning, construction, and operational stages. # # #

A rescue project in Oklahoma

Sacking peanuts is a field job sometimes handled by women workers.

Operation: "Save the Peanuts"

by RHODA RITZENBERG
Washington, D.C.

WHAT does the peanut grower do in Caddo County, Okla., when a shortage of spring and summer rain dries up his cropland?

Turning to Fort Cobb Reservoir for water proved to be a good alternate decision last summer.

Water from the Bureau of Reclamation's Fort Cobb Reservoir was released into the Washita River, then pumped to the thirsty peanut fields. Result was that the farmers who went to this trouble to save their crops are boasting an above average yield for the year.

Actually, these peanut farmers are normally irrigators, but they usually pump their water seasonally from wells. Their problem arises when a shortage of spring and summer rains causes the level of water in the wells to recede too low for practical use.

Arrangements for emergency irrigation use of some of the reservoir water to normally noncontract farmers were made during the detailed planning stage and before construction in the late 1950's of the Reclamation water project.

Fort Cobb Dam and Reservoir are two of the principal features of Reclamation's Washita Basin Project in southwestern Oklahoma. Water stored in the reservoir is released through the Anadarko Aqueduct for municipal and industrial uses in the cities of Fort Cobb and Anadarko, and to the Western Farmers Electric Cooperative.

Foss Dam and Reservoir also are on the project and both the Foss and Fort Cobb facilities provide recreation enjoyment with such activities as swimming, beach relaxation, sightseeing, picnicking, camping, water skiing, boating, fishing, and hunting.

After Water Rescue

After the "crop rescue operation" with the Reclamation water last summer, it was the time of year when farm laborers and harvesting machinery appear on the flatland fields.

A variety of machines are used in peanut har-

Plowing and windrowing makes the peanut crop ready for the combine.

esting. To the uninitiated, much of this equipment ooks like unnamable Rube Goldberg creations, ut actually they are tractors, plows, combines, and oppers.

The tractor and the plow it pulls are the first wo harvesting machines to intrude into the tangle f peanut vines, forming the vines into windrows. Next, the combine, or thrasher, picks up the crop rom the windrows and separates the peanuts from he vines. The peanuts are blown into a cagelike in atop the combine, and the coarsely chopped ine is spewed out the rear of the machine.

The chopped vine, peanut hay, is a valuable by-product. Being richer in protein than alfalfa hay, t is baled and sold as livestock feed.

The peanuts are dumped from the combine into truck which transports them to the hopper. The opper, a giant version of the peanut and candy ending machine found in public buildings, funnels the peanuts into a potato bag.

In Caddo County, migrant workers from the ower Rio Grande Valley of Texas are hired to elp harvest the peanut crop. The employee takes n empty potato sack to the rear of the hopper nd opens the trapdoor allowing the new peanuts o flow into the sack. When a sack is full it weighs bout 40 pounds. They are all tied securely and et out to dry.

ome Females

Although this is hard, physical work, women nd young girls do some of the jobs.

Rows of sacked peanuts are left drying in the ield for approximately 4 days. Each day the sacks re turned, assuring that the peanuts will dry venly. When their turn comes to be hauled to market they are stacked tightly onto a truck.

2-581 O - 71 - 2

Stack 'em high and stack 'em tight—is the way loaders work.

The peanut hay is baled and picked up later from the field.

For the farmer, months of working and waiting are about over. The face of his field is now open to the sun, and he leaves it that way for whatever enrichment nature and farmer administer before the next seeding time.

The peanut harvest from the farms using Reclamation water was above average, the farmers say. Although totals have not been compiled at this printing, the 1970 harvest is expected to exceed the crop of 1969 when 31,000 acres in Caddo County produced 58,000 tons of peanuts valued at $14.5 million. # # #

Seemingly endless rows of sacked peanuts will soon be hauled away.

WATER Quiz

1. If it were not for irrigation, the Montrose, Colo., area would not produce food in such prize winning varieties as shown here from Reclamation's Uncompahgre Project. What is the average amount of rain per year for that State?
   a. 14.8 inches
   b. 17.4 inches

2. What percentage of the earth's surface is wrapped in water?

3. There are liquids besides water which form on the earth's surface. True or False?

4. When ice formed in ocean water melts, does it change by distillation and keep the salty taste, or does it take on the taste of normal saltless water?

5. This hay loader speeds up the job of gathering baled hay on the Rio Grande Project, N. Mex. How many crops (average) of this irrigated alfalfa hay is grown per year in that southwestern part of the State?
   a. two to three
   b. five to six
   c. ten to eleven

ANSWERS:

1. (a) 14.8 inches; 2. 70 percent; 3. False; 4. Taste normally saltless; 5. Five to six crops.

Milder climate and three-season sports

These two Wyoming youngsters, who appear to be thriving, have good words for the skiing, fishing and boating on Bighorn Canyon reservoir. They are Beverly Bovee of Powell, and Steve Knopp of Cody.

Wyoming's Big Horn Fortress of Nature

by LARRY ROOP, Associate Editor
***Wyoming Wildlife* magazine**

BEARING resemblance to a huge walled fortress, the Big Horn Basin has always been an area set apart from the rest of Wyoming by formidable, natural barriers.

Surrounded by high mountain ranges on three sides and rough foothills in Montana to the north, the Basin resembles an enormous bowl with a center rougly 70 by 90 miles in size.

(The 15-mile-long southern arm of spectacular Bighorn Lake is located in the Wyoming section of the Basin. This 70-mile-long lake and Yellowtail Dam which impounds the lake, were built by the Bureau of Reclamation.)

For 20 years the Big Horn Basin and Big Horn County were one and the same.

But beginning in 1911 Hot Springs, Park, and

This is at Horseshoe Bend, a short drive from Lovell, Wyo.

Washakie counties were formed in the Basin and Big Horn County became the northeast quarter of the "bowl," as it remains today. Even though the jurisdiction was split by county lines, much of the early history of this area is inseparable from that of Big Horn County and the Basin as a whole.

That the Basin was entered by explorers in the 1700's is often disputed, but most historians agree that John Colter, after parting with the Lewis and Clark Expedition, ventured into this region in 1806–07. The unbelievable tales he returned with of this area and the Yellowstone country to the west were scoffed at by many, but his reports nevertheless started a stream of trappers and traders into the Big Horn River country.

Bridger Cutoff

One of those drawn by Colter's stores was Jim Bridger, who later laid out the "Bridger Cutoff" through the Basin in order to escort parties to the Montana gold fields. Had the Bridger trail been more popular than the Bozeman trail to the east of the Big Horn Mountains, a great deal of bloodshed might have been avoided. The Bozeman trail passed through several hundred miles of hostile Sioux territory and was marked by so many bloody battles that it had to be closed.

Bozeman himself was killed by Indians along the ill fated trail.

The Basin, on the other hand, was an area relatively free of Indian skirmishes. Originally the valley of the Big Horn was the land of the Crow Indians, although the warlike Sioux tribes frequently harassed them and often held sway east of the Big Horn River. The Crow remained here until 1868 when they were moved to Montana because the Government signed a treaty with the Shoshone and Arapahoe to give them this country.

When settlers finally did penetrate this area they were greeted by surprisingly friendly Indians, largely because of the diplomacy of the great leader of the Shoshone, Chief Washakie.

But for many years the Basin was bypassed on overland routes to the north or south, and by the time white men in any number began pushing into the valley the Golden Age of the West was nearly over. This was partly because of the impenetrable mountains and partly because of the Army's commitment with the Indians to keep settlers out of the region.

Montana Gold Fields

Gold seekers were the first to pour through the Basin, but they had their sights set on the Montana gold fields.

In 1879 cattle were first brought into the south side of the Basin along Owl Creek, and within only 5 years several herds of from 10,000 to 50,000 head followed. Free range was already diminishing in other areas and the grasslands in the Big Horn Basin were there for the taking.

Mormon and German immigrants began to settle along the creeks and rivers, and they built irrigation canals to turn the arid flats into productive croplands. The slopes of the foothills and mountains proved to be marvelous pasture for sheep, and flocks sprung up everywhere. And in the pattern typical throughout the West, when cattlemen began to feel the pressure from homesteaders and

BIG HORN COUNTY

County seat: Basin
Population: 12,202 (1970)
Area: 3,176 square miles
Major sources of income: Agriculture, petroleum, minerals
Average growing season: 118–154 days
Annual mean temperature: 46.4 degrees
Average precipitation: 6.2 inches
Average snowfall: 23.4 inches
Land ownership:
- Private: 337,000 acres
- Government: 1,621,000 acres
- State and county: 74,640 acres

ieepherders, a struggle for the free public domain as inevitable.

The Big Horn Basin range war actually consted of only one raid in 1909, and quick legal ction was all that kept it from becoming a vicious attle. Ranchers had established a line over which heepmen were warned not to cross. When it was rossed eight cattlemen raided the camp at night, illing three sheepherders and many of the sheep.

When the raiders were brought to trial in the ounty seat of Basin, the town became an armed amp for the two factions. The National Guard revented further violence and conviction of the nurderers eased tensions, thus the Spring Creek aid became the last great conflict between cattleien and sheepmen in Wyoming.

Today Big Horn County is as modern and thrivng as any part of Wyoming, although land travel o this area from any direction but the north still equires a drive through high mountain passes or eep, scenic canyons. Elevations vary from 4,000 eet on the west side of the county to 13,000 feet 1 the eastern mountains.

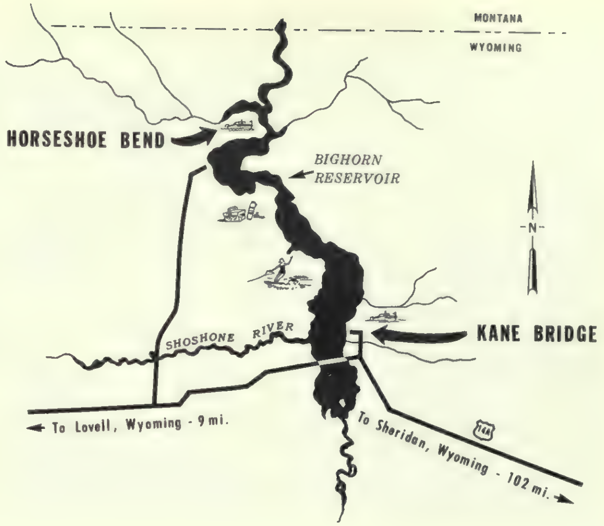
ertile Level Areas

The basin floor consists of arid benches and teraces that are nearly devoid of vegetation except y the watercourses. Even sagebrush, one of Wyoing's most common plants, is scarce here because f sparse rainfall. This results in a "badland" ppearance over much of the terrain, but the fairly evel areas respond well to irrigation.

The Big Horn Mountains rise abruptly to high, calloped peaks on the eastern side of the county, nd the western exposure of this range is barren nd sharply dissected by deep canyons. Shell Canyon, the passageway for one of the roads from Sheridan, is a spectacular example of these esarpments.

Once over the first western summit the mounains are covered with dense forests or lush neadows.

The climate of the entire basin is milder than nost other parts of the State since the encircling eaks act as a buffer against the elements. The trong winds so typical on the plains are rare here. Sunny days are frequent and winters are relatively nild, but unfortunately coupled with this good veather is a dearth of rainfall. Fronts moving rom the west drop their moisture on the Gallatin nd Absaroka Ranges before reaching the Basin.



Water, therefore, is a precious resource throughout the valley, but fortunately flowages are so abundant that it has not been necessary to tap large underground sources.

Wyoming's 15 Miles

The Big Horn River flows south to north through the county and is joined by several tributaries from the east and west. Before emptying into the Yellowstone River, the Big Horn is impounded by Yellowtail Dam in Montana to create a lake 70 miles long, 15 of which stretch into Wyoming.

Major population centers are the towns of Lovell, Greybull, and Basin. Even though Basin is the county seat, it is the smallest of the three because most of the factories and industries are located in Lovell and Greybull.

The population of Big Horn County has been declining for several years as a result of a decline in the county's major industry—oil and gas production. Recent signs indicate that both the population and economy have stabilized.

Economics of the region center largely around mineral extractive industries and agriculture. While oil and gas production is lower than in past years, it is still responsible for 60 percent of the county's income.

Other important mineral industries are two bentonite processing plants and the only producing plant of clay products (brick, tile, glazed sewer pipe, etc.) in the State. Uranium, coal and gypsum

are but a few of the other minerals found in the county.

The bentonite plants, Dresser Minerals and Wyo-Ben Products, Inc., are to be commended for their industrialization with a conscientious approach. After the bentonite is removed the hills are resculptured so that evidence of mining is negligible, and only recently both plants have installed expensive dust filtering systems at their plants.

Crop Variety

Although a great variety of crops are grown in the basin, the largest proportion of irrigated lands are used to produce either hay and forage or sugar beets. A large sugar beet processing plant is located in Lovell.

Cattle, sheep, and swine production accounts for the greatest percentage of agricultural income. Improved methods for feeding livestock and the use of beet and bean byproducts have helped increase cattle and swine production in recent years.

The most promising potential for future development in Big Horn County is in recreation. Bighorn Canyon National Recreation Area is rapidly growing in popularity and offers excellent boating facilities, fishing, and miles of spectacular shoreline scenery.

The Big Horn Mountains are often overlooked by tourists, but have long been a favorite recreation spot for Wyomingites.

There is no longer any slack season in the Big Horn National Forest since vehicles can be seen streaming into the mountains with skis or snowmobiles in the winter, fishing and camping gear in the summer, and horse trailers and hunting gear in the fall.

Visitors to the area can enjoy a wide variety of activities from fishing in fast-flowing mountain streams to hunting for fossils in the famous dinosaur beds.

Rich in Relics

The expansive areas of exposed and eroded clay and bedrock in the region are rich in Indian relics, fossils, and semiprecious stones, as evidenced by the excellent geological and archeological collections in the small Greybull City Museum.

There are numerous points of interest in the county such as the mysterious medicine wheel high on the slopes of the Big Horns, a curious spiral-shaped rock structure that archeologists are still at a loss to explain.

For the hunter, variety is still the key word. Some of the best chukar and cottontail hunting in the State can be had in the lowlands, and mule deer, elk, and black bear hunting in the foothills and mountains draws large numbers of hunters each year.

The Game and Fish Commission's Yellowtail wildlife unit near Lovell is probably one of the few places a hunter can bag pheasants, chukar, and Hungarian partridge, bobwhite quail, ducks, Canada geese, and cottontail rabbits in one small area.

Sage grouse and antelope are also found in the county in moderate numbers. Turkey were released near Shell, but the gobbler population has not grown enough to allow hunting.

Bighorn Lake has yet to reach its full potential as a fishery, but fishermen are already boasting catches of rainbow and mackinaw trout, walleye, yellow perch, largemouth bass, and ling.

83 Kinds of Fish

The many mountain streams and crystal-clear, high-country lakes are stocked with 83 varieties of game fish, some of the more popular of which are

Sugar beets grown throughout the basin are processed here.
(Wyoming Wildlife photo)

This is the historic site of the famous Ten Sleep Raid trial. An old county seat courthouse was replaced by this structure in 1918. *(Wyoming Wildlife photo)*

the cutthroat, rainbow, eastern brook, and golden trout. This is still the type of country where everyone can find his own private spot to cast a fly or lure.

As more and more people seek escape from the pressures of urban and industrial areas, Big Horn County will no doubt grow in popularity. County residents readily take advantage of the opportunities for quality recreation at their back door.

An occasional shopping trip to Worland or Billings, Mont., may be made to enjoy the advantages of bigger cities, but academic standards and social activities are not lacking. Some of the best high school basketball and football teams in the State have come from this area and the average education level is unusually high.

It is little wonder that people from these parts never fail to boast that they are from "The Basin."

Tops in Gamebirds

As an editor's note to author Larry Roop's interesting article, recreation facilities on the Bighorn Lake shorelines include boat-launching ramps, camping, picnicking facilities, and parking areas at Horseshoe Bend and Kane Bridge. Also at Horseshoe Bend are a beach and a fish cleaning facility.

Photographers and bird watchers will find a variety of waterfowl, songbirds, and shore birds in the area, which includes special wildlife areas along the Shoshone River. This tributary flows into Bighorn Lake from the West. The wildlife area is managed by the Wyoming Game and Fish Commission.

The Yellowtail Reclamation Unit has a tremendous potential for waterfowl and upland gamebird hunting and is presently considered the top upland gamebird area in the State of Wyoming.

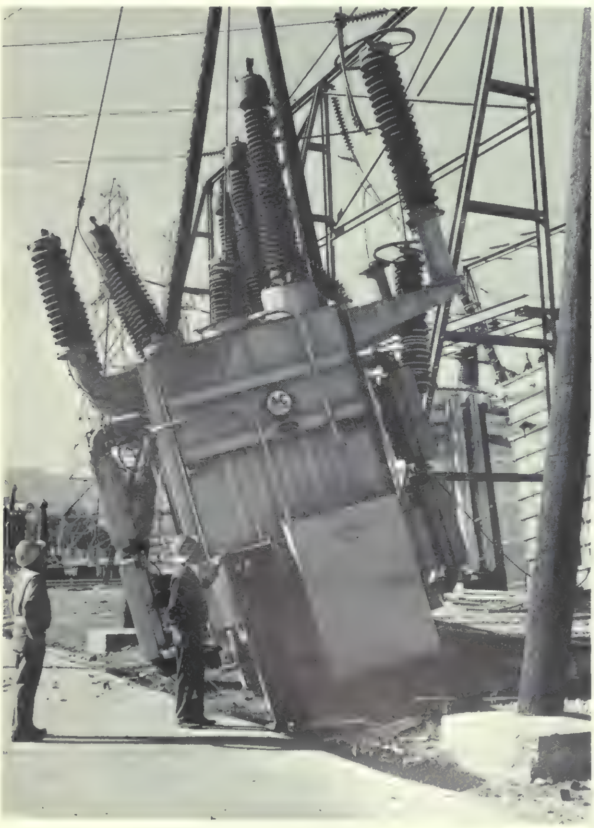
Added information about recreation in the area is available from the Bighorn Canyon National Recreation Area, Box 458, Y.R.S., Hardin, Mont. 59035. # # #

(Appreciation for use of this article goes to the editor of *Wyoming Wildlife* also to the author Mr. Roop. In addition to his present position, the author has worked as a naturalist for the National Park Service and a biologist for the Bureau of Sport Fisheries and Wildlife.)

$93 million damages to water and power

Quake Deals Blow to Los Angeles

Workmen check damage to equipment at Olive Switching station in Sylmar. Because of the destruction, power plants 1 and 2 and the Owens Gorge plants were separated from the system. Temporary connections returned these plants to the system. *(Photo courtesy of Dept. of Water and Power, Los Angeles)*



ONE of the most destructive earthquakes in recent years struck the Los Angeles, Calif., area shortly after midnight last February 9 causing great damage to that urban area.

Over 60 persons were killed, serious fires broke out, buildings buckled, and highways collapsed. Damage to the water systems of the area was estimated at $48 million, and to the electric power system, $45 million, totaling $93 million damages to such facilities, according to the Los Angeles Department of Water and Power.

By request from the Office of Emergency Planning, three men from Reclamation's Region 3 office at Boulder City, Nev., and Phoenix, Ariz., were assigned to assist in inspecting and appraising damage to the electrical transmission, distribution, and substation facilities in the area, except for the Sylmar Converter Station. Sylmar was the hardest hit area, that power facility was wrecked and put out of service, and it was being checked by representatives of the Bonneville Power Administration.

During part of the emergency period, Reclamation generating facilities in the Southwest furnished approximately 270 megawatts of power to the Southern California system. The Bureau's power facilities in the region are available on an emergency standby basis to assist as may be needed while reconstruction takes place.

The Sylmar direct current converter station is the Los Angeles terminal of the 800,000-volt d.c. line from the Pacific Northwest. Loss of this facility on the Pacific Intertie, which was dedicated just last September, means that power from the Northwest—around 525,000 kilowatts—will not be available during this summer when peak demands for power occur.

According to word from the Reclamation San Bernardino office, a few miles north of Los Angeles, there was no destruction to the water project facilities in that area.

During the first few hectic days after the disaster, attention was centered on the severely damaged 50-year-old Van Norman Reservoir, a Los Angeles water supply facility constructed by the Corps of Engineers. Earthfill dams impounding water in this lower reservoir and in the smaller upper reservoir were both extensively damaged, but neither dam failed. # # #

FIFTY YEARS AGO
in Our Magazine

EL PASO—PROJECT TOWN AND METROPOLIS OF THE REAL SOUTHWEST.

IN explanation of the subject chosen by the writer, a few comments upon what constitutes a "project town" and the "real Southwest" might not be out of order.

In the same manner that the seat of government of a nation became known as a national capital, of a State the State capital, of a county the county seat, so, also, have we come to speak of the town where the headquarters office of a reclamation project is located as the project town. El Paso is the project town for the Rio Grande project.

During May and early June the requests for loans of reclamation films and slides were numerous. Flathead, Rio Grande, Snake River Valley, Idaho, Salt River, Yuma, Grand Valley, and Carlsbad reels were in circulation in Virginia, Ohio, and Indiana. A set of four reels containing the principal engineering structures of the service and numerous scenes illustrating the use of labor-saving machinery were assembled and delivered to the Czecho-Slovak Legation in Washington. The films will be taken this month to the new Republic of Czechoslovakia by Mr. Stanislav Spacek, engineer of the legation.

A 5-cent Piece, and How it Grew.

Once upon a time there was a boy who wanted to raise pure-bred stock. This is a true story. The boy's name is Van Palmtree, and he lives at Panola, Miss. Now, Van had no money, but one day his teacher rewarded some especially good behavior by presenting the boy with a nickel.

A nickel means little to the ordinary boy these days, but to Van it meant a herd of pure-bred cattle. With it he bought a chicken. The chicken was crippled, hence its low price, but much coddling on his part saved its life and it grew to maturity. The next summer she raised a brood of chickens which sold for $1.50. With this money Van bought a poor little runt pig. A few months care and good feeding made the pig well worth the $9.36 for which its owner sold it.

Immediately the young financier bought a heifer calf with the money paid him for the hog. Last year, and again this she presented her owner with a heifer calf, so that he now has a little herd of three, all the outgrowth of that one nickel which he invested four years ago.

Van's cattle are scrubs, but he is determined to increase his herd until its sale will bring the money required to at least make a payment on his first pure bred. His success is a foregone conclusion.

ELEPHANT BUTTE DAM SAVES MILLIONS.

"This is the third time the dam has saved us several million dollars within a short space of three years, to wit, in 1919 there wouldn't have been enough water to have matured a third of a crop. In 1920 we would have had a flood that would have caused at the very least calculation $500,000 worth of damage. Instead this valley produced between four and five million dollars worth of crops. The same condition will prevail this year as prevailed in 1919, so that it is seen that in the three years we have been saved from two disastrous drouths and one ruinous flood.

"We repeat again, that if it had not been for the United States Reclamation Service we would either have had no water or a tule swamp. Let us hear no more talk about blowing up the dam.

Powell, an up-to-date little city on the Shoshone project, Wyoming, has a new claim to fame. It is proclaimed by local papers to be the first town in the Big Horn Basin to employ a woman for its town clerk. The young lady is Miss Anne M. Jelik, a stenographer and bookkeeper in a local law office. Her appointment was made through a motion at the town council meeting, which was given unanimous approval.

Destroying Lice on Dairy Cattle.

On the Newlands project, Nevada, a demonstration was conducted recently for destroying lice on dairy cattle. The material used was kerosene emulsion made in the proportion of 1 bar of laundry soap and 1 pint of kerosene to 5 gallons of soft water. This dip is inexpensive and can be made from materials always on hand. It is free from odors and leaves the animal's skin in good condition and is quite destructive to the nits. This treatment for lice has been found very effective on all classes of live stock.

Work at office, farm, and construction

Laws Encourag

APPROACH of the summertime school recess brought a reminder to employers that Federal child labor laws contain special provisions to encourage employment of students.

Those 18 years of age and over may be employed in any kind of a job, and there are no restrictions on the type of work that may be offered them at the Federal minimum wage of $1.60 an hour, according to the U.S. Department of Labor's Wage-Hour Division.

Dismissed as groundless is the idea that the employer encounters problems with Federal child labor laws when hiring teenagers.

If employers are in the retail or service industry, or in agriculture, there are provisions for special minimum wage rates less than the statutory minimum for full time students—those who attend an accredited school and who work only during hours they are not attending classes or during school vacations.

The Fair Labor Standards Act permits granting certificates to individual retail and service and farm establishments, authorizing them to pay full-time students at 85 percent of the applicable Federal minimum wage—$1.60 an hour in nonfarm employment and $1.30 an hour in agriculture.

The only jobs not open to teenagers under 18 are those that the Secretary of Labor has declared hazardous. Some jobs are open to 16- and 17-year-olds even in the hazardous occupations.

Hazardous Jobs

Occupations excluded as hazardous are:

- Working with explosives and radioactive materials;
- Operating certain power-driven woodworking, metal-working and paper-products machinery;
- Operating various types of power-driven saws and guillotine shears;
- Operating most hoisting apparatus such as forklifts and man lifts;
- Most jobs in slaughterhouses and meat packing and processing;
- Most jobs in mining. All jobs in roofing and demolition. Some jobs in excavation;
- Most jobs in logging and sawmill operations;
- And most jobs in manufacturing bricks, tiles, and similar products.

Workers 14 and 15 years old are protected by the hazardous occupation standards and in addition, they may not be employed in manufacturing occupations or in most processing occupations, nor may they clean or repair power-driven machinery.

Hiring Teenagers

Neither may they be employed as public messengers.

Office and Sales

In work connected with warehousing, storage, transportation, communications, public utilities and construction, 14- and 15-year-olds may hold office and sales jobs.

Workers under 16 years old may be employed only between the hours of 7 a.m. and 9 p.m. from June 1 to Labor Day, and they may work no more than 8 hours in a day nor more than 40 hours in a week.

However, the word-hour restrictions do not apply to farmwork outside school hours; nor to newspaper delivery to consumers; caddying; performing in theatrical, motion picture, or broadcast productions; nor to children working for their parents in nonmanufacturing jobs.

Farmworkers must be over 16 to work in dangerous jobs such as operating certain tractors and farm machinery, handling dangerous agricultural chemicals, working in enclosed areas with certain types of breeding animals or in places deficient in oxygen or containing toxic atmosphere, such as some storage areas and manure pits.

The age limit for engaging in certain hazardous agricultural occupations is lowered to 14 for youths who have taken 4–H Club or vocational agricultural training on tractors and certain farm machinery. The restrictions do not apply to children of any age working in agriculture for their parents.

State Laws

Most State child labor laws require employers to obtain employment or age certificates (work permits) from minor employees. The Fair Labor Standards Act contains no such requirement, but it is a good practice because it protects employers from unintentionally violating the law.

Hopefully, employers across America will contact their State employment offices and hire teenagers this summer. It will also help if they will contact school officials and colleges and let them know of job openings. To a teenager, a job means money for school, valuable work experience, the start of a work career . . . the chance to be somebody."

Additional and more specific information about U.S. child labor regulations may be obtained from Wage and Hour and Public Contract Division offices listed under U.S. Government, Department of Labor, in telephone directories in major cities across the country. # # #

NEWS NOTES

First Power From Morrow Point

First power from Morrow Point Powerplant, Colo., went "on the line" December 23, 1970. As power production began, many variously colored lights on a nearby Christmas tree in the powerplant began to glow, then brightened as the generator attained full speed.

Energy from Morrow Point Dam and Powerplant adds to Colorado River Storage Project kilowatts delivered upon demand to customers in Utah, Arizona, California, Wyoming, New Mexico, and Colorado. Revenue from the sale of power is used to reimburse the Federal Treasury for the project construction costs.

To Furnish Industrial Water From Yellowtail

Execution of a Bureau of Reclamation contract for sale of 30,000 acre-feet of water annually to the Panhandle Eastern Pipe Line Co., Houston, Tex., from the Yellowtail Unit of the Missouri River Basin Project for use in Wyoming, recently was executed.

The signing of this contract was another step forward in the marketing of industrial water allocated from Bighorn Lake to be used in developing the coal resources of Wyoming and Montana.

To Protect Lake Water Quality

The Bureau has awarded a $10,000 contract to the University of Arizona for investigations of micronutrients and biological patterns in Lake Mead. To further the Bureau's water quality protection activities, it is important to know the micronutrient levels and functional relationships between nutrients and biological productivity in Lake Mead and the effects of these relationships on the lake's ecosystem. Studies at the university are to be completed by June 30, 1971.

MRBP Renamed

Public Law 91–576, approved December 24, 1970, changed the name of the Missouri River Basin Project to the Pick-Sloan Missouri Basin program. Any work that is currently in progress should be completed using the old name. Any work started after February 9, 1971, requiring project identification should bear the new name.

Environmental Study at Auburn Dam

The Bureau of Reclamation has contracted with a joint venture of engineers-architects-scientists for a study of the impact of Auburn Dam in northern California to form a basis for actions to preserve and enhance environmental values.

The joint venture is comprised of Kennedy Engineers and Royston, Hanamoto, Beck, and Abey, both of San Francisco; and Jara Applied Sciences, Inc., of Sacramento, Calif. The Kennedy firm is a well-known consultant, specializing in sanitary engineering. Royston, Hanamoto, Beck, and Abey are landscape architects. Jara is an environmental scientific firm.

The contract calls for collaborating closely with other Federal, State, and local government agencies, including the Auburn City Planning Commission and officials representing Placer and El Dorado Counties to coordinate activities directed toward formation of a master environmental plan.

Involvement of conservation-environmental groups will be sought by the contractors as they

Bureau of Reclamation
Water Headquarters Offices

COMMISSIONER'S OFFICE:
C St. between 18th & 19th Sts. NW
Washington, D.C. 20240

CHIEF ENGINEER'S OFFICE:
Bldg. 67, Denver Federal Center
Denver, Colo. 80225

IDAHO (Except SE tip)
WASHINGTON
MONTANA (NW corner)
OREGON (Except Southern wedge)
(Region 1)
Federal Bldg.,
550 W. Fort St.,
Boise, Idaho 83707

CALIFORNIA (Northern & Central)
NEVADA (Northern & Central)
OREGON (Southern wedge)
(Region 2)
Federal Bldg.,
2800 Cottage Way,
Sacramento, Calif., 95825

NEVADA (Southern)
CALIFORNIA (Southern)
ARIZONA (Except NE tip)
UTAH (SW tip)
(Region 3)
P.O. Box 427
Boulder City, Nev. 89005

UTAH (Except SW tip)
COLORADO (Western)
NEW MEXICO (NW tip)
WYOMING (SW tip)
IDAHO (SE tip)
(Region 4)
P.O. Box 11568
125 S. State St.
Salt Lake City, Utah 84111

TEXAS
OKLAHOMA
KANSAS (Southern half)
NEW MEXICO (Except W third)
COLORADO (Southern wedge)
(Region 5)
P.O. Box 1609
Herring Plaza, 317 East Third
Amarillo, Tex. 79105

MONTANA (Except NW corner)
NORTH DAKOTA
SOUTH DAKOTA
WYOMING (Northern)
(Region 6)
P.O. Box 2553
316 N. 26th St.
Billings, Mont. 59103

COLORADO (Eastern)
NEBRASKA
KANSAS (Northern)
WYOMING (SE)
(Region 7)
Bldg. 20, Denver Federal Center
Denver, Colo. 80225

develop guidelines to deal with Reclamation's planning and operations during and after construction of the dam.

Project Skywater '70 Brochure

"Project Skywater '70," an illustrated 16-page brochure on the Reclamation program of precipitation management during fiscal year 1970, has been published, and is available without cost.

Draft of Environmental Statement

Construction and operation of the proposed Cosumnes River Division in California "would have a significant beneficial affect on the quality of the human environment" the Bureau of Reclamation says in the draft of an environmental statement.

The draft statement dealing with the proposed development in California's Central Valley has been sent to interested Federal and State agencies for review and comment.

"We will consider all comments received when we prepare our feasibility report to the Secretary of the Interior for his approval and adoption as a step toward requesting Presidential endorsement and congressional action to authorize construction of this needed water resource development," Commissioner of Reclamation Ellis L. Armstrong said.

Plans for construction and operation of the division have been developed cooperatively by the Bureau of Reclamation and other Federal agencies, the State of California, and interested organizations and individuals in the area.

The statement says that in addition to improving the socioeconomic environment, the development would increase outdoor recreation opportunities, and "upland game and fish populations and resulting hunting opportunities would be increased by the development through recommended plans for improving the wildlife habitat."

The proposed development is designed to provide municipal and industrial water supplies, irrigation, flood control, water quality control, outdoor recreation, and fish and wildlife enhancement. Construction of the initial phase would enable irrigation of about 35,000 acres in the division where only about 5,000 scattered acres are irrigated.

Wildlife Habitat in New Mexico

The Bureau of Reclamation has made 680 acres of land near Elephant Butte Reservoir in New Mexico available to the Bureau of Land Management for wildlife habitat.

The marshy area will serve as a nesting place for the Mexican duck, which has been declared an endangered species by the Bureau of Sport Fisheries and Wildlife.

It will also offer protection and propagation of habitat to the double-breasted cormorant and the black-crowned night heron, both of which nest in the area.

Tehachapi-Cummings Loan Approved

A small Reclamation projects loan repayment contract under which the Tehachapi-Cummings County Water District in California will repay a Bureau of Reclamation loan of $6.5 million to help finance water supply facilities, was approved recently.

The district, located in central Kern County, about 40 miles southeast of Bakersfield, will contribute $1,571,500 toward the project's total cost of $8,071,500.

The district embraces a total of 210,000 acres but there are only about 12,700 irrigable acres because of the mountainous terrain.

The area is now served by ground water from private wells so the district has no irrigation or distribution system works. Except for three distribution laterals, users will provide their own delivery facilities. Due to an overdraft on the water supply for many years the water level is steadily declining.

Publication for Economists and Engineers

A technical manual outlining use of interest factors in economic analysis of Bureau of Reclamation water projects has been published.

The publication, which contains both new and updated material, will be a valuable reference to engineers and economists.

Prepared at the Engineering and Research Center, Denver, by Bruce P. Glenn, Division of Planning Coordination, and Edmund Barbour, Western United States Water Plan, the manual covers basic principles of the time value of money and one of interest factors in making economic comparisons between values that occur in different points in time.

The new material covers principles of discounting and scheduling for economic analysis of Federal projects. Updated sections include computer

programs for deriving tables of interest factors, tables of development period factors, and payout tables.

Copies of the manual, costing $1.50 each, may be obtained from the Government Printing Office, Washington, D.C. 20402, or the Bureau of Reclamation, Denver Federal Center, Denver, Colo. 80225.

Cloud Seeding for Texas

The Bureau of Reclamation has awarded a contract to the Texas Water Development Board for a 3-year program of summer cloud-seeding to develop techniques aimed at increasing rainfall.

A result of the research is expected to include increased runoff of the Concho River above Twin Buttes Reservoir, a major unit of Reclamation's multiple-purpose San Angelo project. The city of San Angelo has experienced severe water shortages, resulting in rationing of water in recent years.

The $850,000 project will involve the seeding of suitable convective clouds during the period from April to September through 1973. Seeding will be conducted by aircraft over a 4,600-square-mile area west and northwest of San Angelo, in central Texas.

The Texas Water Development Board is expected to contract with a qualified scientific-meteorological firm for the actual seeding to begin this summer.

The effort is a part of the Bureau of Reclamation's Project Skywater, a program of scientific research begun in 1962 to explore whether cloud-seeding can produce additional supplies of water efficiently, economically, and in a socially acceptable manner.

Roosevelt Dam and Project Named Landmark

The American Society of Civil Engineers has designated Theodore Roosevelt Dam and the Salt River project near Phoenix, Ariz., as a National Historic Civil Engineering Landmark. Completed in 1911, this multipurpose dam was one of the first structures undertaken by the Bureau of Reclamation.

ASCE presented a plaque of the dam's and project's new award at a national water resources meeting last January 14, in Phoenix.

This is part of the netting operation at the catfish farm.

Catfish Grow in Replacement Water

Mesquite Lake Catfish Farm in southern California, where tasty catfish are grown in a system of ponds, reported recently that the operation uses an average of 200 acre-feet per month of water replacing the amounts lost from normal evaporation and seepage.

The farm harvested nearly 30 million pounds of catfish last year, as mentioned in an article in the November 1970 issue of *Reclamation Era*. The fish bring a better price—pound for pound—than beef, pork, or poultry.

The farm's water replacement system is not a continuous flow-through type. Replacement waters are purchased from the Imperial Irrigation District (which receives Bureau of Reclamation water) at $2.30 per acre-foot.

An error in the article in the November issue indicated that one-half million gallons of Colorado River water were used. This should read one-half billion gallons. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. no.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
R-12-3	Atmospheric Water Resources Management program.	Jan. 1	Development and application of atmospheric water resource and management technology in connection with the atmospheric water resources management program of the Bureau of Reclamation.	Texas Water Development Board, Tex.	$850,000
-6844	Central Valley, Calif	Jan. 5	Furnishing and installing acoustic flow-measuring system for the Pleasant Valley pumping plant.	Westinghouse Electric Corp., Underseas Division, Ocean Research & Engineering Laboratory, Annapolis, Md.	107,390
-6585	Columbia Basin, Wash	Jan. 4	1,900-ton gantry for Grand Coulee third powerplant	R. A. Hanson Co., Spokane, Wash.	1,095,000
C-819	Newlands, Nev	Jan. 4	Emergency rehabilitation of Truckee canal system	Crooks Bros. Construction Co., Sparks, Nev.	545,243
C-289	Pecos River Basin Water Salvage, N. Mex.	Jan. 8	Clearing Pecos River—Alamagordo area	J. D. Dutton, Inc., Olympia, Wash.	147,850
C-746	Pick-Sloan Missouri Basin program, Nebr.	Jan. 28	Earthwork and structures, Culbertson extension canal, subsurface drain 17-3-30, schedule 1.	Bushman Construction Co., St. Joseph, Mo.	104,797
C-470	Central Utah, Utah	Feb. 5	Stillwater tunnel outlet portal access road	Jerico Construction Co. and Highland Construction Co., Murray, Utah.	303,111
-6866	Fryingpan-Arkansas, Colo.	Feb. 25	Pump-turbine for Mount Elbert pumped-storage powerplant, unit No. 1.	Allis-Chalmers Manufacturing Co., York, Pa.	1,740,436
-6867	Central Valley, Calif	Feb. 11	Earthwork, concrete lining and structures, Folsom south canal-reach 2, station 828+80 to station 1424+45.	Western Contracting Co., Sioux City, Iowa	7,923,497
-6870	Columbia Basin, Wash	Feb. 26	230-kv. high-pressure oil, pipe-type cable system for Grand Coulee pumping plant.	Donald W. Close Corp., Seattle, Wash.	364,073
-6873	Central Valley, Calif	Mar. 19	Gravel cleaner for Tehama-Colusa Canal, reach 1	R. A. Hanson Co., Inc., Spokane, Wash.	681,901
-6874	Central Valley, Calif	Mar. 30	Shortcut pipeline	McGuire & Hester, Oakland, Calif.	2,866,160

RECENT BID REQUESTS*

Project	Description of work or material
Boulder Canyon, Nev.	Work will consist of removing a 1,200-sq-ft structural-steel penstock platform and 50 lin ft of 3-ft-wide steel stairs; excavating a 7.5- by 7.75-ft opening through a 7-ft-thick reinforced concrete wall; fabricating and installing a 28- by 35-ft steel plate platform with structural-steel supports and 40 lin ft of structural-steel stairs with concrete-filled treads; constructing a 25- by 25- by 8-ft-high visitors enclosure and a 7.5- by 7.75- by 7-ft entrance of steel tubes, asbestos-cement board and glass panels, and steel doors and frames; placing a 6-in.-thick concrete floor with curbs and gutters, and installing lighting for the 8- to 10-ft-wide and 330-ft-long penstock adit. Hoover Powerplant Visitors. At Hoover Dam, 6 miles northeast of Boulder City.
Central Utah, Utah.	Earthwork and structures for the 15.1 miles of 78-in.-diameter Jordan Aqueduct with heads varying from 25 to 375 ft, extending from the intake to a treatment plant area and from the treatment plant area to 5900 South St. In Salt Lake County, extending from Point-of-the-Mountain in the southernmost extreme of the county, northerly along the west side of the valley, terminating at 5900 South and 3600 West in Salt Lake City.
Do	Constructing about 4.5 miles of 6- through 15-in.-diameter buried pipe drains. Vernal Unit, Block 2, near Vernal.
Central Valley, Calif	Constructing a 5,200-sq-ft O&M building, a 5,700-sq-ft general maintenance warehouse and shop building, and a 2,800-sq-ft vehicle maintenance building. Each building is to be slab on grade with steel frame, metal roof decking, and concrete masonry wall filler panels. Work will also include constructing a water pumping station with treatment facilities, and a septic tank with disposal field; grading, curbs, and gutters; bituminous surfacing; landscaping; and fencing. Approximate area of site is 14 acres with about 6 acres receiving pavement, buildings, and landscaping. Coalinga O&M Center about 15 miles northeast of Coalinga.
Do	Constructing a reinforced concrete baffled apron drop 450 ft wide, across Elder Creek, about 250 ft downstream from the Corning Canal crossing of Elder Creek. On Elder Creek, about 8 miles north of Corning.
Do	Constructing 28.6 miles of 12- through 72-in.-diameter pipeline with heads varying from 25 through 125 ft; 2 slide-gate structures, and 3 reinforced water screen and recirculating structures; and installing 12 vertical-shaft pumping units with a capacity range of 2.9 to 9.5 cfs with heads up to 28 ft. Westlands Laterals 31-1.5, 32, 36 and 37 near Huron.
Do	Furnishing and laying about 34 miles of 12- through 54-in.-diameter pressure pipe with heads varying from 25 to 220 ft. Westlands Laterals 6 and 8 near Mendota.
Do	Furnishing, installing, and testing one 13.8-kv armature winding for a 75,000-kva generator. Shasta powerplant.
Chief Joseph Dam, Wash.	Constructing the eight-unit, 96.4-cfs, reinforced concrete, sumptype, outdoor Lake Chelan Pumping Plant. Structures will include: the pumping plant, which is to be 58 ft wide by 80 ft long and 37 ft deep, complete with concrete-encased manifolds; and a reinforced concrete control building, 19 ft wide by 47 ft long and 21 ft high, supported on caisson piles. Work will also include furnishing and installing vertical pumps, motors, valves and valve-operating equipment, trashracks, bulkhead gates, traveling water screens, electrical controls, and associated electrical equipment; furnishing and laying about 0.8 mile of 48-in.-diameter pressure pipe with heads varying from 125 to 400 ft; and furnishing and erecting a 50-ft-diameter steel tank, about 26 ft high. Constructing and surfacing 0.45 mile of 18-ft-wide access road. On the shore of Lake Chelan, 1.5 miles east of Manson.
Colorado River Storage, Colo.	Grading and shaping about 2 miles of roadway; placing 1,300 lin ft of gravel road surfacing and 375 lin ft of rock road surfacing; placing rock blanketing around foundations of seven steel towers; and constructing culverts, low-water crossings, and fence gates. Hayden-Archer Transmission Line Roads between Walden, Colorado, and Archer.
Columbia Basin, Wash.	Work for the installation of Grand Coulee Pumping-Generating Units P/G7 and P/G8 will consist of placing mass concrete, blockout concrete, miscellaneous concrete, concrete architectural finishes, and removing some existing concrete; furnishing and installing metalwork; installing spiral case extensions, two pump-turbines, two governors; furnishing and installing piping; furnishing and installing electrical conduit, electrical wires and cables, lighting fixtures, wiring devices, and other electrical equipment; installing a power transformer, isolated-phase bus structures, switchgear, protective equipment, and control equipment for the two generator/motor units. The 50,000-kva generator/motor units and the 230-kv pipe-type cable system will be furnished and installed under other contracts at Grand Coulee Dam, about 32 miles northeast of Coulee City.
Do	Constructing concrete foundations; furnishing and erecti steel structures; furnishing and installing three unit su stations; installing nine 500-kv power circuit break and separately mounted current transformers; furnishi and installing related electrical equipment; string about 4 circuit miles of transformer circuits; constructi a 100- by 200-ft reinforced concrete service and wa house building; and grading, surfacing, and fenci Grand Coulee 500-kv Switchyard, Cable Spreading Ya and Transformer Circuits, Stage 01. Left abutment a of Grand Coulee Dam.
Do	Constructing a reinforced concrete pumping plant a furnishing and installing two 25-cfs pump units; removi one 21-cfs pump unit from a pumping plant and installi it in the new plant and removing the old pumping pla structure; and furnishing and installing about 6,000 ft 36-in.-diameter discharge line. Quincy Pumping Pla Modifications about 6 miles east of Quincy.
Do	Constructing about 18.3 miles of pipe drains. Block 16 nor of Pasco.
Do	Constructing about 10.7 miles of D15–65–2 buried pi drains and PE51A wasteway. Block 15 west of Eltop
Do	Two unit control boards for control of generator/mot Units P/G7 and P/G8. Grand Coulee Pumping-Gen ating Plant.
Do	Two 13.8-kv-13.8-kv, 10-mva/12.5-mva, OA/FA, 3-ph power transformers; one 6.9-kv-13.8-kv, 10-mva/12 mva, OA/FA, 3-phase power transformer; Two generat voltage isolated-phase bus structures: and One segregat phase bus structure. All for station-service supply Grand Coulee Third Powerplant.
Eden, Wyoming	Earthwork, pipe, and structures for earth lining 2.5 mi of laterals; enlarging 2.5 miles of laterals; and construct 1 wasteway and enlarging 18 turnouts. Eden area ab 36 miles north of Rock Springs.
Fryingpan-Arkansas, Colo.	Work will consist of constructing the Mt. Elbert Pump Storage Powerplant; and inlet-outlet structure and g structure; and a penstock connecting the gate structu and the plant. The pumped-storage powerplant will a reinforced concrete structure about 146 by 186 ft in p and 180 ft high to accommodate one 100-mw reversi generating unit initially and to provide space for a seco similar unit to be installed at a later date. One floor is be supported by a structural-steel framework, and t roof of precast concrete tees. Excavation at the powerpla will include a pit about 150 ft deep and a 100-ft-wi tailrace channel to be armored with riprap. A deto section of State Highway No. 82 is to be constructed a maintained. Construction will include a buried 15- diameter steel penstock about 3,000 ft long and, fo future penstock, about 890 ft of 15-ft-diameter stubs at t reservoir inlet-outlet structure and at the power pla The gate structure, to be located at the end of a 120-ft-wi inlet-outlet channel from the reservoir, will be of reinfor concrete and will house two 12.5- by 15-ft wheel-moun penstock gates in a 82-ft-high gate shaft. At the top of gate shaft a reinforced concrete house is to be contruct to house gate hoists and controls. A compacted earth di is to be constructed around the gate shaft and the inl outlet structure. Dewatering the powerplant excavati will be required. Work will also include construction of access road to the gate structure. At the northwest cor of the lower (eastern) lake of twin Lakes, about 12 mi south of Leadville.
Do	Furnishing, installing, and testing one vertical-shaft, phase, 60-hertz, hydraulic generator/motor having synchronous motor rating of 163,500 hp at 180 rpm, 11, volts, 100 percent power factor, and a generator rating 105,300 kva at 180 rpm, 11,500 volts, 95 percent power f tor. Mr. Elbert Pumped-Storage Power plant.
Parker-Davis, Ariz.	Stage 04 additions to Mesa Substation will consist of co structing concrete foundations; furnishing and erecting steel structure; installing one 230-kv oil-type circ breaker; and furnishing and installing associated elect cal equipment near Mesa.
Pick-Sloan Mo. Basin, Colo.	Stage 03 additions to Beaver Creek Substation will cons of constructing concrete foundations; furnishing a erecting steel structures; and furnishing and installi one 115-kv circuit breaker, two 115-kv capacitor ban and associated electrical equipment, near the intersecti of U.S. Highway No. 34 and State Highway No. 71, the east edge of Brush.
Pick-Sloan Mo. Basin, Iowa.	Stage 08 additions to Sioux City Substation will consist constructing concrete foundations; furnishing and ere ing steel structures; installing one 230-kv oil circuit bre ers; furnishing and installing associated electrical equi ment; and grading, fencing, and placing bitumino surfacing on an extension to the area. About 2 mi southwest of Hinton.
Pick-Sloan Mo. Basin, Kansas	Constructing about 2.3 miles of open drain with botto widths of from 6 to 4 ft; and constructing about 5.8 mi of buried pipe drain varying in size from 6 to 10 in. Bo wick 10–3–5. About 3 miles northeast of Courtland.

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 422-581

RECENT BID REQUESTS* (*Continued*)

Project	Description of work or material
Pick-Sloan Mo. Basin, Montana.	Work will consist of constructing concrete foundations; constructing an 11- by 12-ft concrete masonry service building; furnishing and erecting steel structures; installing seven transformers: one 3-phase, 115-kv, 4,000 kva; three single-phase, 115-kv, 500-kva; and three single-phase, 34.5-kv, 500-kva; installing one 34.5-kv circuit-breaker; furnishing and installing related electrical equipment; constructing about 4,000 ft of single-circuit, 3-phase, 115-kv, eood-pole transmission line; grading, surfacing, and fencing three sites; and constructing about 3,000 ft of access road. Shirley and Terry Pumping Plants. There are four locations which are from 3 to 20 miles southwest of Terry.
Pick-Sloan Mo. Basin, Nebraska.	Stage 02 additions to Grand Island Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; relocating steel structures; furnishing and installing one 345-kv power circuit breaker and related electrical equipment; and relocating one 345-kv power circuit breaker and related electrical equipment. About 3 miles east of Grand Island.
Pick-Sloan Mo. Basin, South Dakota.	Stage 04 additions to Gregory Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; constructing a 22- by 36-ft concrete masonry service building; furnishing and installing two 115-kv circuit breakers and associated electrical equipment; regrading and resurfacing the existing yard; and grading, surfacing, and fencing an extension to the area. About 1 mile south of Gregory.
Do	Stage 08 additions to Sioux Falls Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; installing one 230-kv circuit breaker; furnishing and installing two 115-kv circuit breakers; furnishing and installing associated electrical equipment; and modifying two 230-kv transmission line approach spans. Near Sioux Falls.
Pick-Sloan Mo. Basin, Wyoming.	Constructing a 58-ft-wide by 129-ft-long building which is to have a concrete foundation, masonry walls, precast concrete roof tees, and urethane foam roofing. Interior finishes will include vinyl asbestos floor tile, quarry tile, suspended plaster ceilings, structural glazed wall tile, and painting. A raised floor system and a luminous ceiling will be installed in the control room. Work will also include complete installation of plumbing, air conditioning, and electrical systems. Casper Control Center at Mills, about 2.5 miles west of Casper.
Do	Constructing about 2 miles of double-circuit and 4 miles of single-circuit, 3-phase, 115-kv Cheyenne-Archer North and Cheyenne-Archer South Transmission Lines and constructing new structures for the single-circuit, 3-phase, 115-kv wood-pole Archer-Gering Transmission Line. The work will consist of dismantling and salvaging 8 circuit miles of existing Cheyenne-Archer North and South Transmission Lines; furnishing and erecting wood-pole structures; constructing concrete foundations for steel towers; relocating four existing and furnishing and erecting eight new steel transmission line towers; fencing and gravel surfacing 11 structure sites; and furnishing and stringing three and six 477-Mcm, ACSR conductors and two steel strand overhead ground wires. About 2 miles southeast of Cheyenne.
Do	One 4-channel, single-sideband, carrier-current system. North Platte Area.
Teton Basin, Idaho	Constructing a zoned earth and rock fill dam embankment about 3,050 ft long at the crest with a height of about 305 ft; a power-pumping plant structure consisting of a below-ground, cast-in-place, reinforced concrete substructure about 189 ft long, 87 ft wide, and 54 ft deep; a superstructure about 160 ft long, 57 ft wide, and 37 ft high to be of structural-steel and precast concrete panels. Three 10-mw generating units will be housed within this structure, two of which will be installed in the completion contract and the other to be installed at a later date. The pumping plant portion of this structure will house six motor-driven pumping units with a combined pumping capacity of 70 cfs. Constructing a reinforced concrete inlet structure, about 24 by 55 by 50 ft deep; a river outlet works which will supply water to the river, power and pumping plant; a canal outlet works consisting of an intake structure, a 13-ft 6-in. diameter upstream tunnel, a gate chamber and a shaft house, a 13-ft 6-in. diameter downstream tunnel with steel liner, a steel outlet pipe varying in diameter from 13 ft 6 in. to 9 ft 0 in. with branches and gates, and a stilling basin; a tailrace channel and retaining walls; a 42-in.-diameter pump discharge line 900 ft long and maximum head of 375 ft, to be either precast pressure pipe or lined and coated steel pipe; a canal outlet works control structure, and a 72-in.-diameter pipeline 7,400 ft long with a maximum head of 125 ft; an auxiliary outlet works composed of an intake structure, a 6-ft-diameter upstream tunnel; a gate chamber and adit, and a 7-ft 3-in. diameter downstream tunnel; a spillway which includes an inlet structure with three 20-ft 8-in. by 15-ft 6-in. radial gates, a chute, and a stilling basin; and about 1,800 ft of roadwork. The superstructure portion of the combined gate control and warehouse structure, about 98 by 48 by 15 ft high, will be of structural-steel precast concrete panels and concrete masonry interior walls. This structure will house the gate controls for the river outlet works and also will provide about 3,400 sq ft of garage and warehouse storage area. Teton Dam and Power and Pumping Plant on the Teton River, about 15 miles by road southwest of St. Anthony.

*Subject to change.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

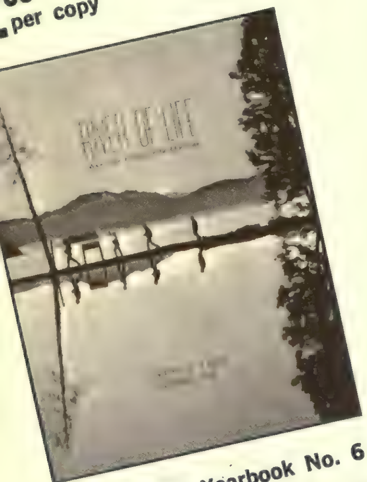
UNITED STATES
OVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

00
per copy



Conservation Yearbook No. 6
CATALOG NO. 11.95:6

River of Life

**WATER:
THE ENVIRONMENTAL
CHALLENGE**

Of all the links in the environmental chain of life, water is one of the most vital. Mankind's very existence depends on this critical resource. Water is the river of all life on this planet, as it has been since the beginning of time. Although the presence of man on earth does not affect the planet's total water supply, man has affected the quality and availability of water at an ever increasing rate.

This first Environmental Report in the Department of Interior Conservation Yearbook series portrays the story of water in vivid natural color, from crystal clear dew-drops to oil-stained oceans.

The Department reports its progress in the regulation, research, wise use and cleansing of the environmental life substance . . . WATER.

The Conservation Yearbooks are all printed in vivid natural full color, big 9" by 12" page size with hundreds of beautiful pictures.

IL ORDER FORM To:

perintendent of Documents, Government Printing Office, Washington, D.C. 20402

*losed find $................ (check, money order, or Supt. of Documents coupons). Please send me ....
ies of*

**ase charge this order
my Deposit Account**

....

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DOCS

____Enclosed____
____To be mailed later____
____Subscription____
Refund____
Coupon refund____
Postage____

FOR PROMPT SHIPMENT, PLEASE PRINT OR TYPE ADDRESS ON LABEL BELOW INCLUDING YOUR ZIP CODE

.S. GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

Name ....

Street address ....

August 1971

RECLAMATION era

A WATER REVIEW QUARTERLY

August 1971 Vol. 57, No. 3

RECLAMATION era

Gordon J. Forsyth, Editor

CONTENTS

COVER PHOTO. The water fountain view is in William Land Park, a municipal recreation facility in a State capital city in a Reclamation area. Try naming the State, or see "Water Quiz," answer to No. 5, page 13.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

A Message From the Secretary

As a Member of Congress and through my service on the House Interior and Insular Affairs Committee, I had the opportunity to get to know many Reclamation employees and to learn much about the valuable function of this bureau. Through working closely with Assistant Secretary Smith, Commissioner Armstrong and many others associated with Reclamation since I became Secretary, I have gained an even greater admiration for the exceptional competence and dedication of Reclamation's employees.

I do wish to take this opportunity briefly to comment on one problem which all of us face today—as employees of Reclamation, of Interior, of the Federal Government and as citizens. Our government has grown in a helter-skelter manner over the years to the point where we are now faced with a conglomeration of bureaus and agencies which overlap and are in fact often at cross purposes.

The fragmentation that exists today has resulted in such a diffusion of responsibility that we now find:

- *—four agencies in two departments involved in the management of our public lands,*
- *—six agencies in three departments administering Federal recreation areas,*
- *—five departments and two agencies concerned with hydropower resources, and*
- *—three departments and several agencies with primary responsibilities in the management and use of our water resources.*

This list of such examples throughout government is almost endless, and I am sure you are well aware of the complications resulting from the present organization.

President Nixon's bold and sweeping new plan to streamline the structure of the Federal Government on the basis of functions indicates that he too is aware of this problem—and he has tackled it head on. The President's Reorganization Plan is now before the Congress and I urge all of you—employee and private citizen alike—to study it carefully. To be built around the Department of the Interior, the Department of Natural Resources would include the Forest Service and Soil Conservation Service, now in Agriculture, the planning and budget functions of the public works program of the Army Corps of Engineers, the National Oceanic and Atmospheric Administration now in Commerce and the related energy functions of the Atomic Energy Commission. I am sure you will agree with me that the proposed Department of Natural Resources will enable us to meet more efficiently and effectively the natural resource challenges of the present and the future.

All of us in Interior—particularly those of you associated with Reclamation—are faced with a gigantic task: to provide the water and power necessary to meet the demands of an ever growing population and economy while at the same time preserve and improve the quality of the environment. We will be better equipped to meet this challenge with the proposed Department of Natural Resources.

I have visited some of the Bureau's projects in the past and look forward to visiting several during "Operation West" this month. I know that by meeting with the individuals involved on the sites and at the projects, I will gain a far better understanding of the problems which confront us today.

Rogers CB Morton

Secretary of the Interior

Jsing geothermal energy from
rast underground water flows

The Roar From An Emerging Resource

by ELLIS L. ARMSTRONG
Commissioner of Reclamation

HIDDEN far below the placid surface of Imperial Valley, Calif., is a boiling caldron of energy from a subterranean ocean of steam and hot water.

This vast reservoir has been confined for ages, and when the surface is punctured, the steam and hot water exits with a roar. It could make pollution-free, odorless, and noiseless powerplants—and become bonus supplies of almost pure water.

The Bureau of Reclamation is preparing to tap this treasure both for the production of electric power and for critically needed potable water in that arid area.

Scientists say that anywhere from 2 to 5 billion acre-feet of the hot water, or steam, lie under the Imperial Valley—enough to cover all of the United States to a depth of several feet. Such a geothermal field has an estimated life of 2 to 3 centuries.

Reclamation investments will include building a production steam well, and a pilot desalting plant in the East Mesa area of the valley at a cost of several million dollars.

The water has been heated to super high temperatures by abnormal heat flow in the earth's crust. Some of this super hot water will flash into steam which can be used above ground to desalt the remaining mineralized water and to generate electric power.

Already harnessed in some areas, this versatile resource could supply usable water for augmenting the Colorado River in behalf of an obligation to Mexico, and for agricultural and municipal and industrial development in this water short area of the nation. Development of such a resource could be accomplished without the environmental hazards of air and water pollution commonly associated with fossil fuel and nuclear powerplants.

Upwelling Rock

Scientists only recently have verified the existence of a global network of upwelling molten rock, called spreading centers, which commonly traverse the floors of the largest oceans. Heat flow from the earth's molten mantle is abnormally high along these mobile liquid centers. East Pacific Rise is the name of the center which also passes under the floor of the Imperial Valley.

Much of the thick layer of earth sediment in th valley is saturated with heated, mineralized wate which is estimated to have a volume of 2 to 5 bil lion acre-feet. A large volume of this water is les saline than sea water.

When the salt concentrations of 1.5 to 2.5 per cent were found as typical, hopes were rekindle that the water could be processed not only fo power, but also for other uses.

Last January the Bureau started a drilling pro gram to explore temperature gradients on Federa lands at East Mesa, at depths ranging from 375 t 1,500 feet. A temperature of 231° was registere at the 375-foot well. Drilling is continuing on th East Mesa anomaly, as the area is called, to deter mine its extent.

In the near future, the Bureau plans to drill steam- and water-producing well field and con struct a prototype desalting plant.

As water flows underground through permeabl heated materials, it becomes heated. Temperature may increase with depth and can become very ho at relatively shallow depths.

Heat Forms

It is thought that the decay of radioactive ele ments, below the earth's surface, and frictiona forces caused by the movement of hot liquids o plastic rocks contribute to the generation of heat

More attention is being given to multipurpos alternatives which will utilize the maximum poten tial from each geothermal development. In severa areas of the world, geothermal sources are compet ing with conventional sources of heat and electrica energy such as natural gas, solid fuels, hydr power, and nuclear energy.

Geothermal sources are presently being utilize for space heating, process drying, agricultura operations, and industry requirements. The ho water has been used for other purposes such a fish breeding, poultry farms, and alligator farms Extraction of chemicals from geothermal fluid may become a profitable resource in some areas.

Geothermal reservoir engineering technology i still in its infancy. However, steam-producin wells are drilled routinely by qualified men, an oil and gas reservoir engineering techniques can b applied to geothermal fields with some modifica tions based on thermodynamics.

A drilling rig operated by Reclamation in Imperial County, Calif.

Apparently no major technological problem has een revealed in the projects under operation at e present time. This technology provides a reas-able evaluation of the geothermal reservoir ca-city and can provide guides for well spacing.

/orldwide Development

Use of water from hot springs and hot caves is robably as old as man. During early times in ome, Greece, and Japan, hot springs were used r space heating. At present, many countries, El alvador, France, Turkey, Algeria, Colombia, zechoslovakia, Yugoslavia, Indonesia, China, and e Philippines, are stepping up their activities in eveloping this vast natural resource.

In 1961, about 420 megawatts (mw.) of geo-ermal electric power were in production through-ut the world. The figure is now over 675 mw. and likely to rise to over 1,000 mw. during the next w years.

:eland

The development of geothermal house heating as continued rapidly in Iceland, doubling from 961 to 1969. Community sites have been planned r it and thermal waters are heating whole towns. Vithin the next decade, it is estimated that 60 to) percent of the population of Iceland will obtain eat for their houses from geothermal sources. A -mw. geothermal power station, the first in Ice-nd, has been developed.

A processing plant is now in operation using eothermal steam for drying diatomite (an earthy aterial used in filters) from deposits on the bot-m of Lake Myvatn in northern Iceland. This ccessful operation results in drying at about one-xth the cost of using fuel oil.

lew Zealand

The main thermal area in New Zealand is in the orth Island where abnormal earth temperatures roduce hot springs, fumaroles (gaseous geysers), nd geysers.

At the Wairakei field, a geothermal power sta-on produces 192 mw. of electric energy; at the awerau field, geothermal steam is used in process-ng pulp and paper and for generating a few mega-atts of electric power. The steam energy at the otorua field is mainly for space heating.

New fields are being explored in New Zealand ainly for the purpose of developing electric nergy sources. The Broadlands field, an initial power station of 120 mw., is scheduled to come into operation in 1976.

Italy

Italy has made the most extensive geothermal energy development in the world for electric power production. In 1969 the Italian geothermal power-plants totaled 384 mw. of installed capacity. Most of the geothermal areas are located near the west coast of Italy, north and south of Rome.

During the last decade, power production from geothermal energy sources increased over 30 percent.

Japan

Japan is one of the most widely renowned volcanic countries in the world and has a number of hot springs and geothermal resources located throughout the island. Depths of production wells range from 1,500 to 4,500 feet.

As a result of some 10 years of prospecting, two geothermal fields have been discovered and developed. Powerplant capacities in these areas range from 10 to 20 mw. The potential in Japan is estimated to be 10,000 mw.

Geologists from the University of California and the Bureau of Reclamation measuring heat flow at Dunes anomaly, hole No. 115.

In addition to power production, Japan now utilizes geothermal energy for recreation, agriculture, and industry.

U.S.S.R.

Scientific investigations, engineering planning and experimenting are now developing on a large scale in Russia. Geothermal maps covering the entire country have been prepared. It is estimated that 50 to 60 percent of the territory is occupied by thermal waters which are available for use.

Advanced project plans have been prepared and integrated systems put in operation or scheduled for space heating, heating greenhouses, and industrial cooling. Other more innovative Russian projects deal with mining in the Arctic regions and with the permafrost problem.

Mexico

The main activity of geothermal development in Mexico is at the Cerro Prieto field near Mexicali located in the Mexicali Valley, which is a prolongation of the Imperial Valley of the United States.

Drilling in this area was initiated in 1959. Steam and water were obtained at 315° Fahrenheit from a depth of about 1,600 feet. Surveys were carried out later to determine the structure of the base rocks.

An exploratory well was drilled in 1964 about 2 miles southeast of the Cerro Prieto volcano in Baja, Mexico. Production of steam at 302° Fahrenheit was obtained at 1,800 to 2,700 feet of depth. In recent years, more than a score of additional deep productive wells have been drilled in this area.

Results of these investigations at the Cerro Prieto field were so encouraging that construction has been initiated for a geothermal powerplant of two generators with a total capacity of 75 mw. This plant is scheduled to be in operation in early 1972.

The Electrical Commission of Mexico has initiated a preliminary survey of all the important hot springs in Mexico, as well as a detailed study in the volcanic belt of central and northwest Mexico.

It is reported that 106 geothermal areas of possible commercial interest were located, and a feasibility study is underway for each of them.

In the United States

Interest in geothermal energy is increasing in the United States on the part of the general public, investment firms, public utilities, and oil cor panies. There are about 1.3 million acres of know geothermal resource areas on public domain in th western United States.

The rise in interest is due mainly to the develo ment of The Geysers field north of San Francisc Calif.

At first, it was a geological curiosity, but no it is estimated that, with the wells already drille 300 mw. of electric capacity can be generated. T proven capacity is 1,300 mw. and the field ma produce 3,000 mw.

With the present generating capacity of 82 mw the cost of producing energy in The Geysers about 4 mills per kilowatt hour as compared to mills average cost produced by conventional plan in California.

Space heating and other uses of geotherm energy have obtained little consideration in t United States because other sources of energy ha been readily available and relatively inexpensiv However, a space heating project is in operati at Klamath Falls, Oreg. Approximately 400 buil ings are heated by over 350 wells.

In Boise, Idaho, 200 homes are heated by h water from two 400-foot deep wells, and at Ca stoga, Calif., hotels, homes, and greenhouses a heated by geothermal water.

Other small communities in Nevada, Californi Oregon, and Idaho use geothermal water to a sma extent as a supply of heat for homes and gree houses.

It appears that areas warranting further e ploration are certain in portions of Nevada ar California, the high Cascade Range of Californi Oregon, and Washington, the Aleutian Islands Alaska, interior basins of Oregon, portions of t Island of Hawaii, and extensive areas of Idah Wyoming, Montana, Utah, and New Mexico.

The Imperial Valley of California has one the greatest potentials for a successful source geothermal steam and water.

Investigation in Imperial Valley

The first geothermal well drilled in the In perial Valley was in 1927. It discharged carbo dioxide gas and was used to operate a commerci dry ice plant. This was the extent of commerci geothermal exploration in the valley for a peri of 30 years.

In 1957, an exploratory oil well was drill about 5 miles south of the exploration carried o

in 1927. The well encountered a brine with a temperature of almost 600° Fahrenheit at depths in excess of 4,700 feet. This discovery essentially discouraged further exploration for gas and oil reserves but rekindled the thoughts of continued geothermal exploration.

The Bureau of Reclamation began long-range planning in 1968 looking toward geothermal resource development. In June of that year, it began providing financial aid by contract to the University of California at Riverside (UCR) which had been conducting geothermal studies in the Imperial Valley since 1964.

UCR investigations under contract with Reclamation included geophysical surveys and temperature measurements leading to the identification of important thermal anomalies. Reclamation also did exploratory drilling to a maximum depth of 1,500 feet. In the past few months three sites called Dunes, Border, and East Mesa were chosen for further study at the eastern side of Imperial Valley on lands withdrawn for Reclamation purposes. Additional deep holes are being drilled on the East Mesa anomaly which has the greatest potential.

The general area in California is the Salton Sea drainage basin which geologists call the Salton Trough, an area comprising about 8,360 square miles. The area includes three important valleys, namely the Coachella, Imperial, and part of the Mexicali. Imperial Valley lies between the Salton Sea and the Mexican border.

The major economic activities of the basin are agriculture, recreation, and light industry. About 500,000 acres of agricultural lands were developed for irrigation by the Bureau of Reclamation and are producing a wide variety of crops. The long growing season permits multiple planting of high value crops that are marketed during the off-season throughout most of the United States.

The industrial development is primarily related to agriculture, such as fruit and produce packing houses, food processing, cotton ginning, well drilling, concrete pipe, and cardboard box maufacturing. The railroad has the largest single payroll in the basin.

Also Tourists

The tourist, resort, and vacation trade has recently gained in prominence, particularly near the Salton Sea.

Mining is primarily sand, gravel, and rock quarrying for the construction industry.

The land status includes private lands, Reclamation withdrawn lands, Indian lands, military reservations, and public domain in Imperial County.

In part, the geothermic action is caused by a belt of weak subterranian crust which extends from the Gulf of California through southern and western California. This area also is known as the San Andreas Fault Zone. The underground belt is characterized by extreme crustal instability manifesting hundreds of earth tremors annually. Occasionally a tremor will reach the magnitude of a damaging earthquake, such as occurred last

This is a steam field in Mexico. The structure which silences the noise of steam coming out of the ground is at left, and the hot water in the ditch is from it. At right is a structure which separates steam from water.

February. This zone also has high heat flowing from the liquid mantle into the crust.

The accumulated thickness of sediment under the Imperial Valley is estimated to be in the order of 20,000 feet made up largely of sand, silt, and clay with some gravel. The sediments are saturated to within a hundred feet of land surface and this is coupled with high heat to result in the significant 5 billion acre-feet of geothermal potential.

Recharging of the ground water reservoir over the centuries has been from flood flows of the Colorado River and from prehistoric streams and flood runoff from the ranges that border the valley. Seepage from the unlined All-American, Coachella, and East Highline Canals built in recent

years also has been a source of recharge by deep percolation.

Recharge flows have exceeded the discharge and substantial water has gone into storage.

Studies show that good quality water can be extracted from mineralized water by modern desalting techniques for augmentation of the Colorado River.

Electric Power

In order to generate electric power economically, the water in the underground reservoir must be from 400 to 600° Fahrenheit. In the most efficient arrangement, a powerplant and a steam-water separator will be connected to several wells some distance away.

Other Uses

Development of geothermal resources could include the recovery of chemicals and minerals, as well as possible precious metals from concentrated liquids. Some private concerns have attempted recovery of minerals salts in the Salton Sea area using open ponds and solar evaporation.

Other possible developments are hot water irrigation during periods of frost, hothouse agriculture, and central heating on a large scale.

Environment

Effects of geothermal development on the nearby environment must be thoroughly studied before major development gets underway. Experience and modern technology in extracting steam and hot water from geothermal fields and disposal of waste fluids indicate that they can be pollution-free processes.

The layout of surface features for a geothermal plant will be located for the best aesthetic viewing, and integrated into the landscape to minimize the disturbance of the natural features. Piping can be located underground and surface structures can be designed and painted to blend with the terrain.

Waste Water Disposal

Disposal of residual geothermal fluids is an important part of the development.

Proposed for the Imperial Valley would be utilization of the geothermal fluids as a water supply for irrigation and municipal and industrial purposes. By desalting, a supply of good quality water would be produced, leaving a small quantit[y] of brine for disposal. The most feasible metho[d] of disposing of the brine, among several possibl[e] methods, would be deep injection into periphera[l] zones of the producing reservoir.

This way would prevent pollution problem[s]. The injection process would be an economica[l] method of brine disposal. The effluent flowin[g] by gravity into the geothermal reservoir where it[s] presence would alleviate some of the reservoi[r] pressure reduction caused by fluid withdrawal. The only cost would be for the injection wells an[d] pipelines, pumping for surface transportation and any conditioning required to prepare th[e] brine for injection.

Gas Emissions

Air pollution could be a problem in a geothermal development if gases such as hydrogen sulphide are present in the steam and released int[o] the atmosphere. However, noxious gas emission[s] can be trapped and chemically removed.

Subsidence

Imperial Valley has a natural ground subsidence rate of about 1 foot per century. Steps ar[e] planned to avoid any increase, if possible, in th[e] rate of subsidence occurring when large-scale geothermal fluid withdrawal gets underway.

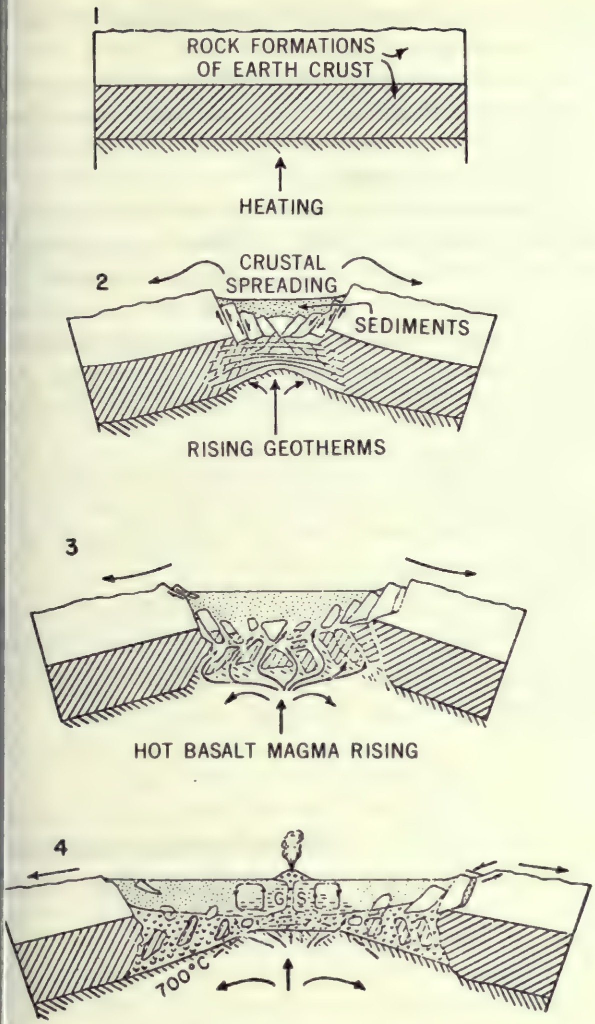
Experience in other areas throughout the worl[d] indicates that ground subsidence can be controlle[d] by water injection pressure maintenance programs. Also ground subsidence monitoring systems would provide an early warning detectio[n] system.

Brine water from desalting plants and othe[r] waste water, such as excess water from Salton Sea could be injected into the reservoir for pressur[e] maintenance.

Utilizing Salton Sea water for this maintenanc[e] will stabilize that body's surface elevation, it[s] salinity, and its nutrient balance. At the sam[e] time such use of some of the Sea's water woul[d] eliminate the need to solve those existing problem[s] and not require more costly solution.

The ocean is an unlimited source for replenishment of the geothermal withdrawals that can b[e] utilized without excessive costs.

The valley floor also is widening at a rate o[f] about 3 inches each year by crustal spreading. However, it is not likely that such spreading



Growth of Rift Valley with geothermal activity.

would have any effect on geothermal developments because the changes would be minor.

Seismology

The Salton Trough is one of the most seismically active areas in the world. It is cut by many faults, most of which are presently mobile. However, the majority of resulting tremors are of a very low order of magnitude.

To find out if the seismic activity would be affected by goethermal development, further studies are required and seismic monitoring stations will be placed at strategic locations throughout the valley before geothermal fields are developed.

Some geophysicists believe high heat flow along fault planes promotes continous creep and thus precludes the movement responsible for damaging earthquakes.

Immediate Program

The Bureau of Reclamation has been planning for sometime to develop a supplemental water supply for the lower Colorado River Basin under Public Law 90–537. One of the potential immediate developments of a supply of water is in the geothermal resources of Imperial Valley.

A 4,500 to 5,500-feet deep well which will be a fully equipped installation will be drilled on the East Mesa anomaly.

This well will be tested to determine quality and quantity of the steam and brine. Also a pilot disposal well would be drilled on the periphery of the potential steam-producing field.

The University of California at Riverside would continue to give technical support.

Long-Range Program

It is felt that a long-range program could ultimately result in development of an entire geothermal field equipped with hardware required for safety, separation of steam and brine, cyclone separators, silencer tanks, and disposal wells.

The Bureau of Reclamation is providing necessary data for the design of a desalting plant by the Office of Saline Water.

High quality design and construction practices will be followed, and protection and enhancement of the environment will be given primary consideration in the continuing geothermal program.

\# # #

LOOKING INTO RESERVOIR SECRETS

Water studies needed from first flows

by MAURICE N. LANGLEY, Chief, Division of Water and Land, Washington, D.C.

IN which parts of rivers do water quality problems start?

Experts reply that a stream may pick up pollution anywhere along its course. But, sometimes, quality problems are present in the first sparkling flows at high elevations.

In view of today's demands for more and better water, an extensive history of the virgin beginning flows is very useful. In addition to the need for studies of virgin flows is the need for a comparison of such waters with whatever water secrets remain in manmade lakes—reservoirs—which man has found necessary for storage at some downstream locations.

To be reliable, the studies and early planning must be fully coordinated to include the stream and all of its reservoirs as a unit—as part of a river basin system in its entirety.

Although this discussion of problems does not deal with lakes—natural impoundments—many of the same, or similar problems, exist in such bodies of water.

There is significant environmental and technological value in developing quality reservoirs. The Bureau of Reclamation has taken a leading role in building and operating high quality impoundments for many years. This agency also has been developing and improving the study methods, the quality and quantity of water and monitoring instrumentation which result in extensive benefits for man.

Today's Capacity

In conjunction with such efforts the Bureau has built 222 reservoirs with a total capacity of over 134 million acre-feet—which is enough water to form a 6½-foot thick cover over the States of Connecticut, Vermont, Rhode Island, New Hampshire, and Massachusetts.

Also the canals and distribution facilities built by Reclamation are capable of serving quality irrigation water to over 10 million acres of land. About one-fifth of the total irrigated acreage in the United States is on Federal Reclamation projects.

As an indication of the complexity of water quality data needs, Reclamation facilities make possible delivery of about 600 million gallons annually of municipal, industrial, and domestic water to some 15 million persons.

Total reservoir surface is about 1.5 million acres, which, along with 11,400 miles of shoreline, provided about 54 million visitor-days of recreation for people last year.

Flood control is only partially related to water quality, but is one of the important multipurposes as illustrated at Shasta Reservoir in California, which, alone, provided over $40 million in flood control benefits during a series of rainstorms in 1970.

Reservoir Upgrades

At most Reclamation projects, the reservoirs and related upgrading of the downstream habitat support a much greater number of fish and waterfowl than the original stream did. Use of these lakes by migratory waterfowl has risen to a total of nearly 500 million duck-days and 70 million goose-days annually.

Reclamation's hydropowerplants in the areas of its dams have an installed power capacity of 7.5 million kilowatts and they produce nearly 50 billion kilowatt hours of generation annually.

On one hand, water quality usually is reduced with each use and reuse of its flows. But on the other hand, it is with use and reuse that the greatest total economic benefits are produced.

A second paradox in water systems is that each water-using entity sees the quality deterioration of other water users, but seldom recognizes his own detrimental usage.

There are a variety of natural effects and upstream uses which affect the quality of water in reservoirs. Such effects point to the need for data upon which to base reservoir operations. Collection of such data should start long before a dam is constructed. The greater the time that quantity and quality studies of streams have been made prior to construction, the more the design of a dam and its outlet works can be useful in providing important water needs of the future.

Nature

Quality of water under virgin conditions is dependent on the geographic, geologic, and climatic environment of its watershed. If the source of supply is from melting snowpack, the water starts essentially in the distilled state. The extent to which precipitation passes through vegetation mulches and ground minerals before reaching the stream, controls its quality.

Irrigation

Although it has great value in many areas, irrigation is the largest single consumer of diverted water, and the greatest depleter of streams. Like other consumptive uses, this evapotranspiration use essentially distills the water. After that, any dissolved solids are left in the return flow of the stream resulting in some concentrated salinity in the water.

Irrigation drainage return flows may pick up salts from the minerals in the ground thereby adding new salts. Also dissolved fertilizers, such as nitrogen and phosphorus, find their way back to the stream with drainage water.

Pollution of return flows by agricultural pesticides also may occur if these are not used as directed by the registered label. In selected instances there may be organic and bacterial pollution from agricultural processing of cattle feedlots.

Municipal and Industrial Uses

Industrial and municipal consumptive use varies greatly from case to case. Water for domestic

429-954 O - 71 - 2

Shasta Reservoir is peaceful in this scene. This lake alone provided over $40 million in flood control benefits in 1970.

purposes results in rather small consumption, while industrial cooling with recycling may equal 80 to 90 percent of the diversion. As in irrigation the concentrating effect of consumptive use on dissolved solids is significant.

Thermal effects of using water for industrial cooling may be good or bad. Warm water discharges from such operations may prevent ice jams in winter and maintain open water for fisherman and waterfowl. In some instances, production of aquatic food supplies has increased and resulted in faster growth of desirable food organisms and fish. In summer months, however, high temperature return flows may be detrimental in some streams.

Return flows from municipal and industrial deliveries vary widely in organic and bacteriological character depending on the degree of sewage treatment. If industrial water is used in processing radioactive materials or in cooling nuclear power plants, special monitoring of radioactivity in the return flows is needed. Sediments and plant or animal biota may be affected by radioactive isotopes in water.

Recreation

Recreationists are often very vocal in demanding high quality water. Yet, pleasure boaters, water skiers, fishermen, and picnickers pollute heavily with human wastes, oil, gasoline, picnic trash, and other debris. So-called sanitary facilities on the shore may also contribute to pollution. Waterborne waste products of warmblooded animals, including man, are the greatest potential source of bacteria that infect man and sometimes result in such diseases as typhoid, leptospirosis, and schistosomiasis.

Fish and Wildlife

There is widespread emphasis on preserving water quality to meet fish and wildlife needs. Yet often overlooked are the potential fecal droppings (nitrogen and phosphate) from the presence of a great many ducks and geese. Algae blooming below certain fish hatcheries indicates that unconsumed fishfood and nitrogen and phosphate nutrients are contributing to the pollution of the water in these areas.

lood Control and Power

Flood control and hydroelectric power genera-ion made possible by water impoundments have ittle or no detrimental effect on water quality ther than that related to the physical nature of he reservoirs required for those purposes.

uality of Impoundment

The geographic and climatic location of a reser-oir along with its size, depth, and configuration, nfluence storage water quality.

Natural minerals, organic residue resulting from ither reservoir clearing or lack of it, and prior use f lands being inundated, all may somewhat influ-nce the quality of the water which initially fills eservoirs. Soluble minerals, such as gypsum, may nfluence the water quality in an impoundment for few years. When fertile fields or pasture lands re flooded in the reservoir area, a tendency toward emporary eutrophication may be created.

eservoir Currents

The motivating mechanism and behavior of res-rvoir currents are little understood. However, it s known that the dispersion and fate of both horeline and streamborne pollutants do, to a con-iderable degree, influence reservoir currents, lensity curents, pressure oscillations, and related henomena. Such conditions have some effects on uality of water in a reservoir.

The configuration of the reservoir, that is, vhether it has bays and long extended arms, and vhether it is in a deep canyon or in a shallow swale, nay directly affect reservoir current patterns.

utrophication

Excessive levels of nutrient material in water, articularly nitrogen and phosphorus from do-nestic waste, industrial waste, and urban and rural unoff, are sources of food for nuisance organisms nd tend to result in their rapid growth.

Although few reservoirs are so afflicted, a high legree of filamentous bacteria make water unfit or many uses. A reservoir generally has a lower ssimilative power for bacteria than a highly erated flowing stream.

aste, Odor, and Color

Storage tends to equalize or smooth out peak oncentrations of taste, odor, and color flowing n a reservoir. On the other hand, taste, odor, and olor can all increase through some bacterial ac-tions while water is in storage. The additions are in hydrogen sulfide, the products of eutrophica-tion, and various manmade pollutants.

Evaporation

Evaporation of reservoirs is a consumptive use of water, and like other consumptive uses may have a concentrating effect on the total dissolved solids. It usually is most pronounced in reservoirs with long holdover periods, in warm climates, and in shallow impoundments.

Sedimentation

Storage space at the lowest level for sediment entrapment is basic in reservoir design. As sedi-ment settles down, water quality is improved.

In rare cases, there may be sufficient suspended material in sediment to produce turbidity within a reservoir. If so, it may have adverse effects on aquatic life by reducing food supplies. Special treatment for such water is available if it is to be used for municipal and industrial purposes.

Stratification

Late springtime warming of the upper waters in a reservoir by increased sun heat, and warm inflow water may create a sufficient lessening in density to prevent wind circulation over a water mass. If this occurs, thermal or density stratification may begin.

Resistance to mixing of water intensifies throughout the summer as the upper waters con-tinue to warm while the temperature of lower water rises only a little from its wintertime tem-perature. Complete mixing of water may not oc-cur again until fall when upper waters cool and sink, and normal temperatures are reestablished.

Lack of reaeration of nonmoving lower waters can influence quality. Bacterial and algae respira-tion sometimes completely consume the dissolved oxygen. This onset of nonoxygen conditions may lead to the formation of hydrogen sulfide or to other critical water breakdowns. Ultimately, the absence of oxygen may cause fermentation in the mud.

To find the intensity and duration of stratifica-tion in a given reservoir for a given weather pat-tern is a difficult problem to solve.

Input and Output

The smoothing effect that a reservoir has upon any quantity or quality of input water is beneficial

Water containing sediment is purposefully sluiced out of Guernsey Reservoir, Wyo., to help stop canal leaks downstream.

to recreation. Uses of a reservoir for recreation and fish and wildlife can be just as rewarding as they are in an upstream location.

If a dam is constructed with multilevel outlet gates, the temperature of the water released through them can be controlled to meet downstream needs.

Helpful Sediment

Usually it is best that sediment be left in a reservoir space provided for it. However, where irrigation water is diverted from storage directly into unlined canals, a reasonable amount of sediment and colloidal (suspended) material is desirable to seal the canals against seepage.

At Guernsey Reservoir on the North Platte River, sluicing the lowest water levels to pick up sediment for canals is an annual procedure.

The rate and timing of discharges from a reservoir have an important influence on the assimilative capacity downstream. Large releases and increased velocity may reduce the travel time so much that it shortens the period needed for adequate breakdown, or biodegradation of pollutants. Releases for generation of peaking power at a hydro plant may sometimes be troublesome in this respect.

Usually, however, adding water to streams from storage, during what would normally be low flow periods, may have highly beneficial effects on recreation, scenic values, biological conditions, power production, navigation, irrigation, commercial fishing, pollution levels, and urban and industrial uses.

Because of the high usefulness of streams and reservoirs, it continues to be important to try to improve them by unlocking more secrets about them and putting the new knowledge into practice.

\# \# \#

WATER Quiz

1. Phil Black of Utah finds a successful fishing position from rocks which are the size specialists install on many shorelines because the rocks are big enough to resist moving and heavy wave erosion. Do you know what this type of shoreline is called?

2. What kind of water defies gravity?

3. Irrigation water service on Reclamation projects result in reliable crop harvests for over 100,000 farm units, some of which are small part time farms. What percent of this farm population are able to depend upon that vocation for their full support?

   a. 58 percent
   b. 65 percent
   c. 72 percent

4. Data on the two highest valued crop harvests on Reclamation projects in the 17 Western States were in fruit and nuts (as one category), and vegetables. The value of one was $457 million, and the other was $402 million for 1969. Which crop category brought the highest figure?

5. Four of Reclamation's seven regional headquarters offices are in state capital cities. Which one of the four state capitols is shown here?

   a. Salt Lake City, Utah
   b. Denver, Colo.
   c. Sacramento, Calif.
   d. Boise, Ida.

ANSWERS:

(1. Rip rap; 2. Steam; 3. c. 72 percent; 4. vegetables; 5. c. Sacramento, Calif.)

Series held in New Mexico Colorado, Utah, and Nevada

MOLES SWEEP 6 FROM BLASTERS

by B. P. BELLPORT, Director Reclamation Office of Design and Construction, Denver, Colo.

NOT many people came to see the contests, but six block-busting games were played in the underground league. Only they were not played; they were worked.

The dirt-eating Moles won all six from the exploding Blasters.

From their first maneuvers, the Moles—which actually are boring machines for transmountain tunnel excavation—seemed destined to stack up a lot of points and probably sweep all six games.

The competition was not really in games, it was in drilling six water transport tunnels.

The mole is "potentially much superior," said a specialist from the Bureau of Mines. The time was ripe for an improvement over the conventional "drill, blast, and muck" techniques of underground excavation.

The Six Tunnels

Using the new machine, tunnel number 1 on the Navajo Indian irrigation project, New Mexico, virtually 2 miles long, was bored through in only 9 months. This was a remarkable achievement in Reclamation record books, even if the tunnel had not been nearly 20 feet in diameter. Twenty feet is about twice the excavated diameter of the other five tunnels.

Another tunnel, the Blanco, on the San Juan-Chama project in Colorado, at a total length of 45,630 feet (8.6 miles), was drilled in 1 year.

Oso Tunnel, also on the San Juan-Chama project, 26,610 feet (over 5 miles) long, was completed in 1 year.

Azotea Tunnel, on the same project as Oso and Blanco, the longest of the six tunnels, at 12½ miles in length, was cut through in 29 months.

Starvation Tunnel on the Central Utah project, Utah, 1 mile long, was excavated in 4 months.

River Mountain Tunnel on the Southern Nevada Water project, Nevada, 3.7 miles long, was drilled in 9 months.

World Records

World records fell at Blanco and Oso Tunnels in Colorado, for single-day excavating. On June 16, 1967, Oso Tunnel "mole" crews achieved a single-day record excavating an amazing 403 feet; and for the month of June this crew drilled 6,581 feet, which is about a mile and one quarter.

Exceptional progress by the "mole" crew at Blanco Tunnel were borings of 367 feet on February 16, 1967, and 375 feet about a month later. The achievement of this crew during the working days only of the month of March was 6,713 feet, also well over a mile.

There are a number of advantages in the use of the mechanical behemoths. The rate of excavation is faster; fewer men are required during excavation; there is less overbreak of the newly cut surface; there is less need for supports because the excavated circular section is more nearly self-supporting; there is less disturbance of surrounding rocks; and excavation is safer as no blasting is required.

Overbreak using the mole averages about 5 percent, compared with 20 percent or more when conventional techniques of "drill, blast, and muck" are employed. The result is that much less concrete is required in lining the tunnels.

Ingenuity Invited

Much of the success of the tunnel-boring machines is due to the Bureau of Reclamation policy of inviting ingenuity from equipment manufacturing industries and construction contractors to develop equipment or methods which result in greater economy or efficiency on Reclamation jobs.

Cutterhead of machine holding through at Tunnel No. 1.

A contractor's proposals for either blasted or machine-excavated tunnels is invited.

The payment provision is set up in such a way that contractors have a choice in excavation methods, an equal opportunity to be low in their bids on Reclamation tunnel construction, and an incentive to be progressive, resourceful and cooperative in their methods.

Laser Beam in New Mexico

The first successful use of lasser beam guidance took place in the tunnel in New Mexico and resulted in an accurate excavation of the bore, within five-eighths inch of established line and grade.

The laser light beam is projected from a laser "gun" which is mounted on a transite in the tunnel. This beam strikes two light-sensitive cells on top of the boring machine which the operator observes to keep guiding the machine in the right direction.

The unusual accuracy of boring with this instrument already is routinely accepted.

An additional, highly worthwhile dollar savings was made as a result of the smoothly machined walls of this tunnel on the Navajo project. About 3½ times less concrete lining material was required than would have been on a more uneven interior which results from excavation by conventional means.

The tunnel in New Mexico is located about 40 miles from the town of Farmington. One thousand

feet of the tunnel were excavated by the conventional drill, blast, and muck method, however, the remaining 9,979 feet were completed by the mole.

The high end of the tunnel was located at the headworks of Reclamation's Navajo Dam on the San Juan River at about elevation 5,970 feet. Designed as a gravity tunnel, the water is lowered only 5 feet between the inlet and the outlet portals.

After being lined with an average of 9 inches of concrete completely coating the interior, this widest of the tunnels is 18 feet in diameter, wide enough to accommodate two average automobiles with some extra air space left over.

Betti-1 is the model name given to the machine which bored the New Mexico tunnel. As the first and the largest of the six machines used, Betti-1 was 64 feet long and weighed 280 tons.

Like a Telescope

Operating somewhat like a telescope, the machine had an outer frame with a cutterhead on its front end, and an inner frame along which the outer frame moved forward with a power thrust of 700 tons. The inner frame functioned as the anchor and the outer frame could advance 5 feet with each thrust.

The anchors on the inner frame were eight hydraulically actuated jack pads, two on each side, two on the top, and two on the bottom which were adjusted to press rigidly against the surface of the tunnel.

Upon completing a 5-foot stroke, four auxiliary jack pads on the outer frame were brought into use while the inner frame telescoped forward and its anchors were repositioned for cutting another 5-foot reach.

The cutterhead was driven by five 200-horsepower electric motors. Six adjustable flaps each had a scraper and two cutting tooth-like wheels revolving on the circumference of the cutterhead. Having a total of 43 powered cutting wheels mounted on it, the entire cutterhead also rotated normally at 5 revolutions per minute, or at a reduced speed of 3½ revolutions per minute.

Power was brought to the machine at 2,300 volts, and transformers at the machine provided 440- and 110-volt services.

Machine Operation

It took 15 minutes to move the machine, anchor it again, and resume cutting. Excavation work proceeded on three, 8-hour shifts per day.

There were 194 working days, the machine was in operation 165 of these days, or 86 percent of the time. The other 14 percent of the working time was needed for maintenance and repairs.

Maximum daily advance through a section of the tunnel not needing rib supports was 160 feet. While the maximum daily advance through a section needing added supports was 97 feet.

Volumes excavated averaged 208 cubic yards per 8-hour shift and 3,127 cubic yards per 5-day week. The machine was removed from the tunnel by moving it out backwards on the track.

Muck Handling

Three locomotives, one 140-horsepower, one 160–170-horsepower, and a 75-horsepower, were used for hauling muck cars and for transporting men and materials in and out of the tunnel.

A total of 22 cars having a capacity of 10 cubic yards each were used, three to five of which were side dump cars for muck hauling.

The 36-inch gage tracks were supported on wooden ties curved on the bottom ends to fit the circular shape of the tunnel.

Muck buckets, mounted on the back of the cutterhead, and rotating with it, fed the pulverized cut material to a conveyor belt on top of the machine. After the machine had excavated its way some 300 feet into the tunnel, a 200-foot-long trailing conveyor was attached to the rear of the machine and the muck was deposited in the cars.

Pneumatic wheels were mounted on the bottom of the long legs supporting the trailing conveyor, and they were pulled along the bottom of the tunnel on either side of the track.

The muck train was driven between the rear support legs and under the trailing conveyor. First car to be filled with muck was the one nearest the locomotive; the train was then pulled back a car at a time to load the other cars.

Loading time was 30 minutes, dumping took 15 minutes, and the average time to complete a cycle of haul out, dump, and return was 75 minutes.

Principal rock type was sandstone, fine to medium with some coarse. The secondary rock type was shale which was silty, and clayey. Beds of shale air slaked (crumbled) rapidly. Shale was encountered about 560 feet in from the outlet portal.

The harder rock could be broken by a light to moderate hammer blow; the softest could be crushed in the hand.

Tunnel Supports

About 44 percent (4,385 feet) of the tunnel was supported by expansion-type rock bolts; half-ring, 4-inch, I-beams; timber; or flexible steel.

Most of the rock was hard enough that there was no crumbling or overbreak of loose material from the top or walls after the cutterhead passed. However, when loose fallout occurred, the area was steeled immediately behind the cutterhead.

Workers gained access to the area of the loose material by using the top of the machine as a working platform.

Ventilation

Initially, the tunnel was ventilated for the benefit of the workers with exhaust fans placed about every 2,500 feet. Also an exhaust fan in a long 16-inch metal tubing was important to disposing of the dust which tunneling work raises.

Tunnel Workers

Key contractor employees hired to drill the tunnel were: three boring machine operators to work an 8-hour shift each, four maintenance men for each 24-hour period, 18 men per 24-hour period to dispose of the muck, plus employees for other jobs totaling 85 men per week, who were paid a total of $12,643 per week.

The contract amount for construction of the tunnel and the headworks by Fenix & Scisson, Inc., Tulsa, Okla., was $5.4 million.

The cost of Betti-1 has been estimated between $750,000 and $1 million. It was built by the Hugh B. Williams Manufacturing Co. of Dallas, Tex., a subsidiary of Hughes Tool Co.

Tunnel number 1 is a principal structure on Reclamation's Navajo Indian irrigation project which has the potential for irrigating 216,000 acres, part of which is in the proposed Animas-LaPlata project in Colorado and New Mexico. It also will provide municipal and industrial water to people in the area.

Blanco Tunnel

No known records for tunnel excavation exceeded Blanco—45,630 feet in a little more than 12 months.

The principal rock type encountered in excavation was shale, and the temperature of the rock was 93°. Dominant minerals were quartz and clay, grain size was fine.

40 Feet Long

The machine which drilled Blanco was 40 feet long, it weighed 60 tons and its thrust was 186 tons. The diameter of the rotating cutterhead could be varied from 9 feet 11 inches to 10 feet 7 inches.

The cutterhead had 24 disk-type roller cutters, each 11 inches in diameter; however, only 22 cutters were used in excavating the 10-foot-diameter section of Blanco. A special beveled bit also was at the center of the cutterhead.

This mole was powered by four 75-horsepower, 440-volt motors. A laser beam was used as the guidance system.

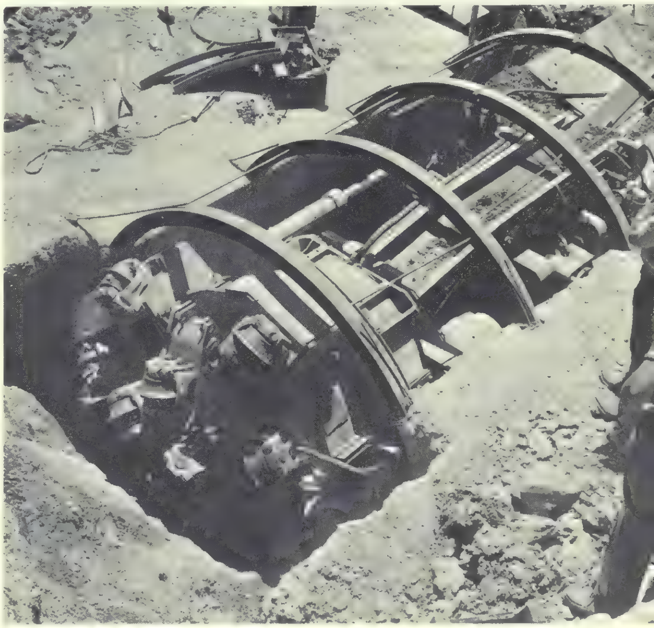
Built-in operating safety features on the machine included dust shield, enclosed ventilation system, explosion-proof lighting, and continuous methane gas monitor.

3-Feet Advance

Length of advance of cutting head was 3 feet and the average 3-foot cut took 10 minutes. Only 2 minutes were required to move the machine to resume cutting.

Excavation work proceeded on 3 shifts per day, and it was the only job, besides Oso, on which work went on during 6 days per week. The maximum rates of advance were 132 feet per shift, and the volume excavated was 1,931 cubic yards per shift.

This 74-ton mole at the edge of Starvation Tunnel will soon be put to work.

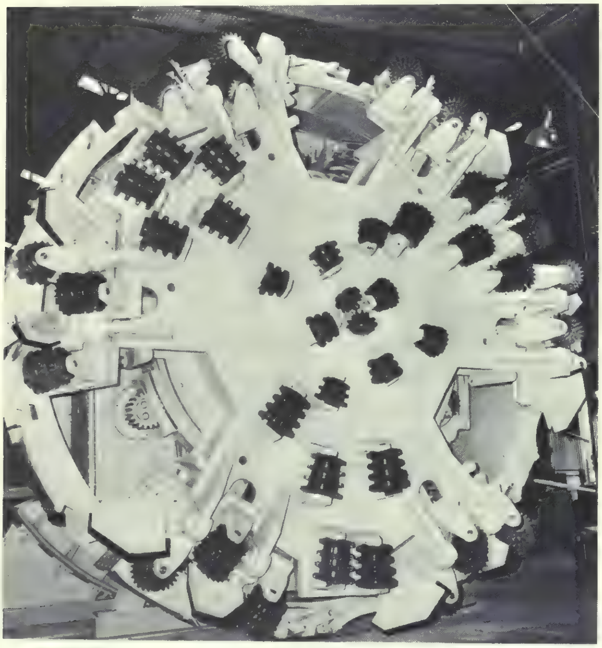


When the average haul distance for tunnel muck was 6½ miles underground, the facing of the tunnel advanced 66.4 feet per shift, or 199.3 feet per day.

The time required to replace one cutter was 30 minutes, and the time to reset or change the bore diameter was 24 hours.

Downtime per week for maintenance and repairs of the machine and supporting equipment was 5 percent.

The machine was removed from the tunnel by partially disassembling the cutterhead and moving it out on the track.



Cutterhead of Betti—1 in full dress.

22 Train Cars

Four trains were used in transporting the muck out of Blanco Tunnel. A 10-ton "Monitor" 220-horsepower locomotive pulled the total of 22 cars on the 24-inch gage track. Each car was 3.5 feet wide, 34 feet long, and had a capacity of 16 cubic yards.

A conveyor belt supported by a gantry was long enough for the train of mine cars and locomotive to run under it. The cars were loaded as they were pulled toward the portal by the locomotive.

Three "California" switches were spaced along the track so that trains could pass in the tunnel and a new train could be pushed under the conveyor.

Supports

In the 41,768 feet of tunnel drilled by machine, 4-inch ring I-beams were used for support for only 294 feet. The remaining length of the tunnel was supported with rock bolts and prepunched and preshaped 16-gage steel mats.

The 24-inch-diameter air duct, extending from the portal to the face, was made of metal. Water sprayed at points of muck transfer controlled the dust.

120 Workers

The number of contractor employees at the tunnel site averaged 120 per week, and the weekly payroll was about $27,000. Fifteen workmen were required to operate the boring machine, five for each 8-hour shift.

The rate of pay was $5.40 per hour for the operator and $3.70 for miners. Maintenance of the boring machine required two workers per shift, and for muck disposal, 10 workmen per shift.

Manufacturer

The diameter of the excavated section was 10 feet, but after completion, Blanco had 6½ inches of concrete lining and the diameter became 8 feet, 7 inches.

The contractor for construction of the tunnel and associated diversion dam was the joint venture firm of Colorado Constructors, Inc., and A. S. Horner Construction Co., Inc., Denver, Colo., in the amount of $10.6 million.

Manufacturer of this model 104–120 boring machine was James S. Robbins & Associates, Inc., Seattle, Wash., and it cost approximately $330,000.

Blanco Tunnel is one of the features of the San Juan-Chama project, which is a participating project of the Colorado River Storage project. The project diverts about 110,000 acre-feet of water from tributaries of the San Juan River as needed for people's homes and industries in the area, and to farmers to grow crops in the Rio Grande Valley.

Oso Tunnel

Drilling the more than 5-mile long Oso Tunnel began at the outlet portal on August 12, 1966, and completion was on August 30, 1967. All except 925 feet were machine drilled.

The principal rock type drilled from this Colorado tunnel was shale much like that from Blanco, and the rock temperature was 74 degrees.

Diameter of the excavated section was 10 feet

2 inches until completion of the concrete lining bringing the diameter to 8 feet 7 inches. The inlet portal is at elevation 7,743.

Differs From Blanco

The tunneling mole was a slightly different model from the one used on Blanco, but it had many of the same measurements. Features built into the machine included a top shield and six water spray nozzles to control dust at the head of the machine. A laser beam was the guide for straight drilling.

Oso Operation

Exceeding that of Blanco, length of advance of the cutterhead was 3.33 feet and the rate of advance ranged up to a maximum of 23.3 feet per hour.

The machine could be moved and made ready for a new cutting in one-half minute.

Excavation of Oso was 74 feet per shift, or 223 feet per day. This was the only job, besides Blanco, on which work was underway during 6 days per week instead of 5.

Replacement of one cutter required 60 minutes to remove the machine from the tunnel, the cutterhead needed to be partially dissembled then it could be pulled out with a tractor.

Fifty side-dump, 5-cubic yard cars were used for hauling. The 24-inch track was supported on wooden ties.

The excavation process was shut down during the 5 to 15-minute interval when the locomotive in the tunnel was switching from about an 11-car string of loaded cars to a string of empty cars.

Loading time was 20 minutes and dumping was completed in 20 minutes. Average time to complete a cycle of load, haulout, dump, and return was 120 minutes.

Supports and Ventilation

The only support system used to reduce fallout in the machine-bored portion of the tunnel consisted of rock bolts and 16-gage steel mats which were 13 inches wide, 9 feet long, prepunched and preshaped to fit the overhead circular arch.

For ventilation, 25-horsepower inline exhaust fans removed dust from the cutting head and openings along the conveyor.

The 24-inch diameter air duct extending from the portal to the working area was made of light-gage metal and was supported by rock bolts and tie wire. Air from the working area was blown through the duct at 12,000 cubic feet per minute.

Water was sprayed to control dust at points of muck transfer, the dust shield, and the cutterhead.

$5.50 for Operators

The 125 contractor's employees working at the Oso site received a total weekly pay of $28,000. The rate of pay for each of the five machine operators was $5.50 per hour.

The construction firm of Boyles Bros. Drilling Co. of Salt Lake City, Utah, completed the tunnel and appurtenant features at a contracted cost of $6,340,987.

Manufacturer of the boring machine model 104–121A, was the same Seattle firm as for the Blanco machine. Approximate cost of the machine was $375,000.

Azotea Tunnel

The 12-mile long Azotea Tunnel is the longest of any of the six tunnels, and it is the lowest of any of the three mentioned Colorado tunnels. Its inlet portal is at elevation 7,662.6 feet.

About 97 percent of this waterway was drilled by boring machine in diameters of 12 feet 8 inches, and 13 feet 5 inches. It was lined with about 10 inches of concrete to complete it at 11 feet in diameter.

Excavation began on January 4, 1965, and the tunnel was completed on May 8, 1968.

Engineering Geology

Starting at the downstream portal, tunnel excavation progressed through a clay shale, then into a formation consisting of hard sandstone in thin to massive beds and often shale varying from a few inches to several feet in thickness.

Tunneling

At 35 feet in length, the machine which bored Azotea Tunnel was the shortest of the six. This one weighed 76 tons and had a thrust of 223 tons. It had two side grippers with a side thrust of 1.2 million pounds.

The mole's cutting action was accomplished with a group of 25 or 29 disk cutter wheels.

Also used in building this tunnel were four 100-horsepower motors for the drill and the laser beam to set exacting direction.

Moves 3½ Feet

The cutterhead of this machine can advance 3½ feet in one setting and the machine can be

telescoped and resume cutting in only 2 minutes.

Excavation work proceeded on three shifts per day, 15 shifts per week at 8 hours per shift.

In the shales, the machine cut an average of 51 feet per shift, or 153 feet per day, while in sandstone, the average cut was 24 feet per shift or 72 feet per day.

The time required for maintenance and repairs of the boring machine was 55 percent. The average time required to reset or change the bore diameter was 24 hours, and to replace one cutter was 30 minutes.

The average train cycle time for load, haulout, dump, and return was about 2½ hours.

Supports

Steel rib supports were used over 36.3 percent of the tunnel. Rock bolts and light gage steel mats were used over 63.7 percent of the tunnel.

Ventilation

Dust control was a constant problem during excavation except when the environment was wet. Various methods used to control the dust included spraying water like a mist on the cutterhead and at muck transfer points. Another problem was the unpredictable occurrence of gas pockets from which methane and occasionally hydrogen sulfide were detected.

The number of contractor's employees at the tunnel site averaged 115 per week; they were paid a total of $25,000 per week.

Used Two Plans

The first plan which the contractor tried was to excavate the tunnel from the downstream end, using a slurry system of muck disposal and placing the final concrete lining behind the machine as he progressed. Because that system of handling muck was not satisfactory, the plan then was to drill about half the tunnel from the downstream end, then excavate from the upstream portal. While this was underway, he would line the outlet half.

However, after boring 30,000 feet in about 15 months, the machine was removed from the tunnel for extensive repair and remodeling due to persistent trouble with the main bearing and a motor.

After repairs, this machine and the machine used on the Oso Tunnel were used to complete the Azotea Tunnel from both ends at the same time.

This also was a model 104–121A machine from the Seattle firm. It cost approximately $400,000.

Contractors for construction of Azotea were Gibbons & Reed Co. and Boyles Bros. Drilling Co. both of Salt Lake City, Utah, and Dugan Graham Co., Inc., of San Francisco, Calif. Contract amount was $13,791,000.

Starvation Tunnel

Due to unstable rock conditions, the contractor on Starvation Tunnel, Utah, backed the boring machine out of the tunnel and adjusted the arms of the cutterhead to cut 9 feet 6 inches instead of the 9 feet he started with. Because loose fallout rocks were being encountered in much of the cutting, he also found it necessary to install many tunnel supports.

So when Starvation Tunnel was later lined with 6½ inches of concrete, its diameter was 7 feet 8 inches, and it can accommodate water flowing at 300 cubic feet per second.

Starting on August 4, 1967, and ending on December 6, the same year, this tunnel was cut through alternating beds of sandstone, siltstone and shale, most ranging from 1 to 6 feet in thickness.

Air slaking (crumbling) and seepage of water accounted for the major reasons for fallout. However, reaches of sandstone were generally free from cracks, caving or fallout problems, and required little or no rib support.

The three Colorado tunnels, Blanco, Oso, and Azotea were all about 2,000 feet higher elevation than Starvation, which is 5,720 at inlet. Navajo Tunnel No. 1 is about 250 feet higher, and River Mountain Tunnel in Nevada is 3,800 lower than Starvation.

The Machine

The machine was 48 feet long, it weighed 33 tons, and had 110 tons of thrust. The 20 disk cutters on the head were made of a special heat-treated carbon steel.

A total 250 man-hours was required for on-site assembly of the boring machine which had two 100-horsepower motors.

Tunneling

The telescoping cutterhead would advance 3 feet per setting and the time required to drill this distance averaged 20 minutes. The time needed to move the machine for another 3 feet of cutting was 1 to 2 minutes.

Average advances of the drilling were 32.2 feet per shift. Work shifts were two 8-hour shifts per

ay for excavation and one 8-hour shift, the graveyard" shift, for maintenance.

No passing for the mining trains was provided nside the tunnel; the empty train waited at the ortal for the loaded train of muck to pass. Exavation was discontinued between trains.

Loading time was 45 minutes for the six train ars and dumping was completed in 15 minutes.

:aving

During the 4-month period between holing hrough and the beginning of cleanup for lining, onsiderable caving occurred. The contractor had o relieve the load on some of the steel supports y placing additional support steel. The time drilling and installing the 4- to 6-foot long rock bolts veraged 5 minutes each.

The number of the contractor's employees at the unnel site averaged 49 per week. They included arpenters, cement masons, ironworkers, laborers, perating engineers, and teamsters, and the total ayroll for them per week was $8,600.

Model number of this machine was 81–113.

The firm which constructed the tunnel and outet portal structure was W. W. Clyde & Co., Springville, Utah. Contract amount was ;1,250,035.

Starvation Tunnel and Dam are part of the Bonneville unit of the Central Utah project which will store and release water for irrigation and nunicipal and industrial uses in the Uinta Basin—and by means of the tunnel through the Wasatch Mountains 5 miles north of Duchesne—n the Bonneville Basin in central Utah.

The unit will have facilities to generate 133,500 kilowatts of hydropower, and will provide beneits to fish and wildlife conservation, recreation, nd flood control.

River Mountains Tunnel

The 3.7-mile long River Mountains Tunnel is, by far, at the lowest elevation of any of the six unnels. Its inlet portal is at 1,907 feet above sea level.

However, the water which flows through it is being pumped up to it from an elevation 685 feet ower. Source of this water is the Nevada side of Lake Mead being impounded behind the famous Hoover Dam.

The 3.7-mile long River Mountains Tunnel, named after the mountains it was drilled through, has several miles of water aqueduct extending from both ends. These features are part of the first stage of the Southern Nevada Water project which will supply 132,000 acre-feet of Colorado River water to Las Vegas, North Las Vegas, Henderson, Nellis Air Force Base, and Boulder City.

Before being lined with 7½ inches of concrete the tunnel was 12 feet in diameter. It now is about 10 feet in diameter and has the capacity to carry 500 cubic feet of water per second.

Excavation on the tunnel began at the outlet portal, elevation 1,887 feet, on September 24, 1968; the machine drilled on an uphill grade, and the other side of the mountain was reached 20 feet higher as planned on June 26, 1969.

Geology

At River Mountains Tunnel, the boring machine drilled such a uniform-size bore with such smooth walls that it had the appearance of a rifle bore.

The principal rock included very hard types and volcanic lava. The interior portions of the lava rock were similar to fine-grained granite. The secondary rock, conglomerate, was only 600 feet long.

Machine

The 65-ton machine was 37 feet long, and it had a thrust of 443 tons. Number and horsepower of motors originally were four at 100 horsepower each; later, the machine was modified to have six 50-horsepower motors.

A gas-filled laser beam was used as the guidance system for the machine.

Operating safety features built into the machine included an enclosed cutterhead and dust shield, a cutoff switch to drive motors, an enclosed ventilation system, and an enclosed conveyor belt.

Shortest Advance

The length of advance of the cutterhead, at 2 feet, was less than any of the others. Its rate of travel ranged from one-half inch per minute to 6 inches per minute, or 36 feet per 8-hour shift.

The time required to move the machine and resume cutting was 1 minute.

Downtime for maintenance and repairs of the tunneling machine was 25 percent. The average time required to replace one cutter was 30 minutes.

Dumper

A rotary car dumper located on a high trestle was used to unload the muck-hauling cars. A locomotive pushed a filled car into a dumper; as the

The laser beam is mounted firmly to the side of the tunnel to avoid being disturbed by tunnel traffic.

dumper overturned the car by rotating it, the load dropped out.

Loading time was 96 minutes for the four cars used in the mucking operations, and dumping was completed in 10 minutes. The average time to haul out, dump, and return the round trip distance of 6 miles was 60 minutes.

The heavy rock bolt tunnel supports were three-fourths of an inch in diameter, 6 feet long and each weighed 8.6 pounds. Time required for drilling and installing a rock bolt averaged 20 minutes.

Ventilation

Dust control throughout most of the tunnel was excellent. Dust was removed from the cutterhead and open ports along the conveyor by exhaust fans.

Water from spray nozzles placed at points of much muck transfer helped control the dust.

Workers

Employees at the tunnel site numbered 48 per week, and their weekly payroll was $12,900.

Manufacturer of the boring machine was Jarva, Inc., Solon, Ohio. Approximate cost of the machine was $500,000.

The $3,946,619 contract to build the tunnel and outlet portal structure was carried out by the Utah Construction & Mining Co. of San Francisco, Calif., and the Fluor Utah Engineers & Constructors, Inc., also of San Francisco.

Tunneling by machine is in early stages of development, but it is a breakthrough from underground excavation by blasting, and its results are impressive.

Even if improvements from continuing research are modest, the National Academy of Science estimates a 30-percent decrease in tunneling costs in 10 years. This could bring about considerable beneficial change in water resource development. # # #

(*This article is a digest from a more complete paper by Mr. Bellport entitled: "Bureau of Reclamation Experience in Use of Boring Machines in Tunnel Excavation," which he presented at the fall meeting of the Society of Mining Engineers at St. Louis, Mo.*)

listorical courthouse restored

Popular Lake Gets Museum

THE old Millerton courthouse was abandoned for 97 years—but it was not forgotten. Some ersons who cared restored the building to a status f dignity.

Now the former court and civic building is open s a museum to show a slice of California's hisory.

The new museum's doors were opened last April nd it is being operated as a feature of the State Parks and Recreation Department. The building tands on Mariner's Point overlooking the blue vaters of Millerton Lake which formed behind Friant Dam built on the San Joaquin River in 944. The Bureau of Reclamation built the dam vhich formed the lake.

The courthouse was constructed in 1866 and 867, after the Civil War ended. For 7 years it was ısed for holding court, jailing prisoners, and conlucting county and church meetings. In 1874 the voters of Fresno County turned down Millerton ıs the county seat, probably due to quick changng fortunes of gold rush locations, and moved everything, lock, stock, and barrel, to the boomng new town of Fresno.

Sporadic attempts were made over the years to lo something about the idle county government building. In the early 1940's, when the waters started to rise behind the new Friant Dam, money was raised for a contractor to tear down the old building and for its great granite blocks to be numbered and stored for future use high above the dam. Now the original site is 100 feet below the waters of Millerton Lake.

Good Location

A considerable population resides around the Millerton Lake area. It is about 25 miles northeast of Fresno, a city of 162,000 people. It is about 20 miles east of Madera, a city of 16,000. A number of smaller towns are nearby.

The new building being enjoyed by visitors even before it was ready to open as a museum.

To have a picnic is one of the things a family can do at Millerton Lake.

Friant Dam and Millerton Lake are Reclamation's multipurpose facilities which provide water storage mainly to irrigate the farmer's crops in the area, control flood conditions of the river, and for extensive recreational use.

The recreational use in the Millerton Lake area increased remarkably from the 5,500 persons in 1969 to a peak day of more than 9,200 persons in 1970. The total visitor-days of use jumped from 366,000 in 1969 to 574,000 in 1970.

Five access roads lead to Millerton Lake, and visitors may choose from 11 picnic areas, eight campgrounds with spaces for 165 tents or trailers, and two swimming beaches.

Use of the lake for swimming increased more than any other recreational activity, gaining from 56,700 visitor-days in 1969 to 113,310 visitor-days in 1970. Participation also was high in picnicking which increased from 77,000 to 110,000, and sightseeing from 94,000 to 101,000. Boats may be rented and increases also were seen in boating, waterskiing, fishing, and camping.

The number of sport fish caught was 34,500 in 1970.

Court Again

It was like reliving a day in history as court was convened in the historic courthouse last April 16 for the first time in nearly 100 years. However, the law violation was modern. The case involved an actual vehicle driving violation, and it was held in the room of the former jail. Historians sa court originally was held in an upstairs room no converted to the museum.

Inside the entrance of the main floor are th offices of the sheriff, assessor and tax collecto Each office contains antique desks, and such ol items as record books, guns, handcuffs, and keys

The courthouse, particularly the main floor was reconstructed to appear nearly like the orig inal one by the California Department of Park and Recreation with assistance from the Fresn County Millerton Courthouse Advisory Commit tee. Valuable aid in the restoration also was con tributed by the Native Sons and Daughters of th Golden West.

It is reported that the first occupant of th original thick-walled jail was the contractor wh built the building. He had become involved in a election brawl and killed a man by mistake.

Nearly 1,000 persons turned out for the dedica tion of the museum last April, including stat county, and city officials, and the former Senato who was particularly effective in handling the es sential legislative phase of the restoration. Th Fresno County Board of Supervisors, dressed i early-day western clothing, also held a meeting i the building last spring.

Since April the courthouse has been ope from Wednesday through Sunday, with specia tours arranged at other times for children' groups. # # #

This is the historic court house before it was torn down.

is farm idea means proteins for Indians

Fish Farms in India, Too

THE Indian Government is now making a substantial effort to develop fish production nurseries and reservoirs to increase vitally eded protein into the diet of the people of that untry.

The diet of the average Indian consists prilrily of roti—a round, flat wheat bread, accordg to the American Peace Corps.

Although the stomachs of millions of persons ho survive on that bread may be satisfied, their dies remain starved for protein. At the same ne the water supplies located in the area are ing useless at their feet.

This information about India's fish-for-protein ogram came to our attention shortly after the ovember 1970 issue of *Reclamation Era* included article about a farmer successfully raising 600,- 0 pounds of tasty catfish each year on a 320-acre rm. This farm is in the Imperial Valley, Calif., d gets its water from the diversion works of eclamation's Imperial Dam on the Colorado iver. The *Era* article is entitled: "Whisker Fish arm."

Existence of such farms is quite unusual, but ey have considerable potential for success in eas where conditions are favorable.

The fish raising program in India is scheduled be extended during the summer of 1971 in the stern part of the State of Rajasthan. The proram would not be practical yet in western Rasthan where the huge, waterless Rajasthan esert borders on the Beas River.

roject Underway

However, the Bureau of Reclamation is helping build a gigantic water system in the west utilizg waters of the Beas river. The project will proide important opportunity for irrigation and conomic growth and development in that counry; including, perhaps, even more fish farms.

At the request of the Indian Government, ureau of Reclamation specialists completed asignments three times (1967, 1969, and 1970), in ssisting with the design and construction of both rincipal features, Beas Dam and Rajasthan Canal. The two-man Reclamation team was Thomas P. Bixby, Supervisory Engineer; and Baptiste Michelis, Construction Management Engineer.

Beas Dam will store water for distribution through the Rajasthan Canal to almost 2.9 million acres of the fertile desert.

A Peace Corps representative, commenting on the fish program, said that reservoirs, rivers, lakes, rice fields, and village ponds throughout India abound with life—life which could support human life by providing vitally needed protein. Yet millions of India's people have never tasted fish.

Because of the promise of the protein production, fish nurseries and reservoirs staffed by Government personnel have begun to have results in some of the States.

Six Peace Corps volunteers are working at fisheries at present, and training for a new group will begin this summer. It is important that all volunteers to the program have a strong science background and that as many as possible hold degrees and be competent in biology, fisheries management, conservation, ichthylogy, limnology, or related fields. # # #

Fish farming efforts in India.

Training for journeymen positions in construction

PROGRAM FOR NAVAJO YOUTHS

Sheepherding has long been a principal pursuit of Navajos in N Mexico. Job training in construction is one variation for Nav youth being undertaken by Reclamation.

A construction job training program for Navajo Indian youths has been initiated this year by the Bureau of Reclamation.

The program will provide an increase of skilled craftsmen on the Navajo Indian Reservation to be employed in the construction, operation and maintenance of Reclamation's Navajo Indian irrigation project now underway, and other construction efforts.

Training of the young Navajo men started in the spring of 1971. The full program lasting approximately 1 year, is designed to provide successive groups of trainees with work during preapprenticeship, apprenticeship, and journeyman stages of employment.

Training will include heavy equipment operation, carpentry, cement finishing, bricklaying, painting, and truck driving, depending upon individual interests of the trainees.

The Bureau of Reclamation is designing and constructing the Navajo water development project for the Navajo Tribe with cooperation of the Bureau of Indian Affairs. Persons in the Navajo Tribe also are receiving training in irrigation operations at the project through cooperation of the Agricultural Experiment Station of New Mexico State University, the State of New Mexico, BIA, and Reclamation.

Age 16 to 22

Recruited among male Navajos, the trainees will be between 16 and 22 years of age, who pass, or show potential to pass, the General Achievement Test Battery and a physical examination. Recruits should either be high school graduates or be able to pass the General Education Development Test.

Selection of the trainees will come from tho eligible for apprenticeship training programs ar will be the responsibility of the Department Labor with assistance from the Navajo Tribe, tl Bureau of Reclamation and other agencies.

The preapprenticeship training programs wi be based on the need to have trained workers f construction and operation of the project. Tl trainees selected will enter residential manpow training centers near Collbran, Colo., Ogden, Uta and possibly other locations.

Upon completion of the preapprenticeshi training, qualifications of the trainees will be r ferred to the Labor-Management Committee of a approved state apprenticeship program. Whe state requirements are met, the trainee will l certified to the construction engineer on the Nava Indian irrigation project.

Each trainee will receive compensation of nc less than $30 per month, plus room, board, an clothing during preapprenticeship training. Upo completion of training, each will receive a lump sum readjustment allowance based on the lengt of time in the program, provided he has been i training at least 6 months. Part of this allowanc may be used to purchase tools needed in his craf

Construction of the Navajo Indian irrigatio project is currently 15 percent complete and wil require about 15 additional years for full com pletion. Portions of the project may be in opera tion and maintenance status in 5 or 6 years prio to full completion. # # #

17 tour stops self explained

Touring Glen Canyon Dam

ON the self-guided tour of Glen Canyon Dam in Arizona, you will ride on three different elevators, walk through a tunnel, and cross a bridge. Total walking distance, round trip, is about one-third of a mile, and something interesting is always going on.

You may proceed at your own pace, but an average visit takes around 30 minutes. The areas you will visit are safe, but there are "no admittance" and "restricted area" signs which are for your protection. Benches are provided for those who wish to rest along the way.

The tour begins on the elevator at the visitor center, which will carry you 110 feet down to the level of the crest of the dam. Upon your exit from the visitor center elevator you will enter a short tunnel marked Tour Stop 2 through which you will walk to the crest of the dam marked Tour Stop 3.

The crest length of Glen Canyon Dam is 1,560 feet, the width of the roadway and sidewalks totals 35 feet. Embedded in the concrete are rails for the 190-ton gantry crane, the high steel structure on the top of the dam.

The gantry crane is used (infrequently) to install stop logs and remove penstock gates for maintenance. A penstock is a 15-foot diameter steel tube, 500 feet long, through which the water passes from the lake to the turbine.

Small buildings on the upstream side are the chambers containing machinery to operate gates on the penstock intakes. This is explained at Tour Stop 4. The top of the structure can be removed to permit the gantry crane to remove and replace for inspection and maintenance the tremendously heavy penstock gates.

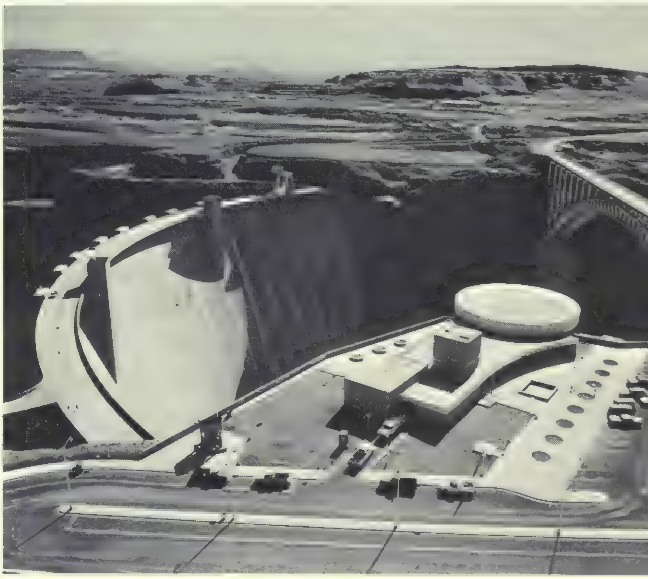
Elevations Seen

You may be interested in noting lake elevations which are posted at various intervals down the edge of the wall.

Upstream from the dam about 2,500 feet, you will see a cable boom on the water all the way across the canyon. This is to keep trash and boats from drifting near the dam.

On either side of the canyon, you can see the channel cut into the canyon wall, creating a bypass, or spillway intake for the water. These channels can be used when elevation of the lake exceeds 3,680 feet.

Spectacular view from left, Glen Canyon Dam, the visitors center, Glen Canyon Bridge.



Tour Stop 5 is about the geology of Glen Canyon. The portion of Glen Canyon you can observe downstream from the dam is typical Navajo sandstone, a thick formation that extends downward about 500 feet below the riverbed. Navajo sandstone is actually solidified sand dunes which are perhaps 150 million years old.

Although in this section of the canyon the walls are sheer and high, the cliffs along most of Lake Powell are dissected into many picturesque formations. This site was chosen for the dam because the canyon is narrow, the rocks are stable with no nearby faults, and the cost of the dam was much less here than it would have been elsewhere.

In the bed of Wahweap Creek, 6 miles from the dam, was located an ample supply of hard rock aggregate that was mixed with cement and water to make concrete for the dam.

Tour Stop 6

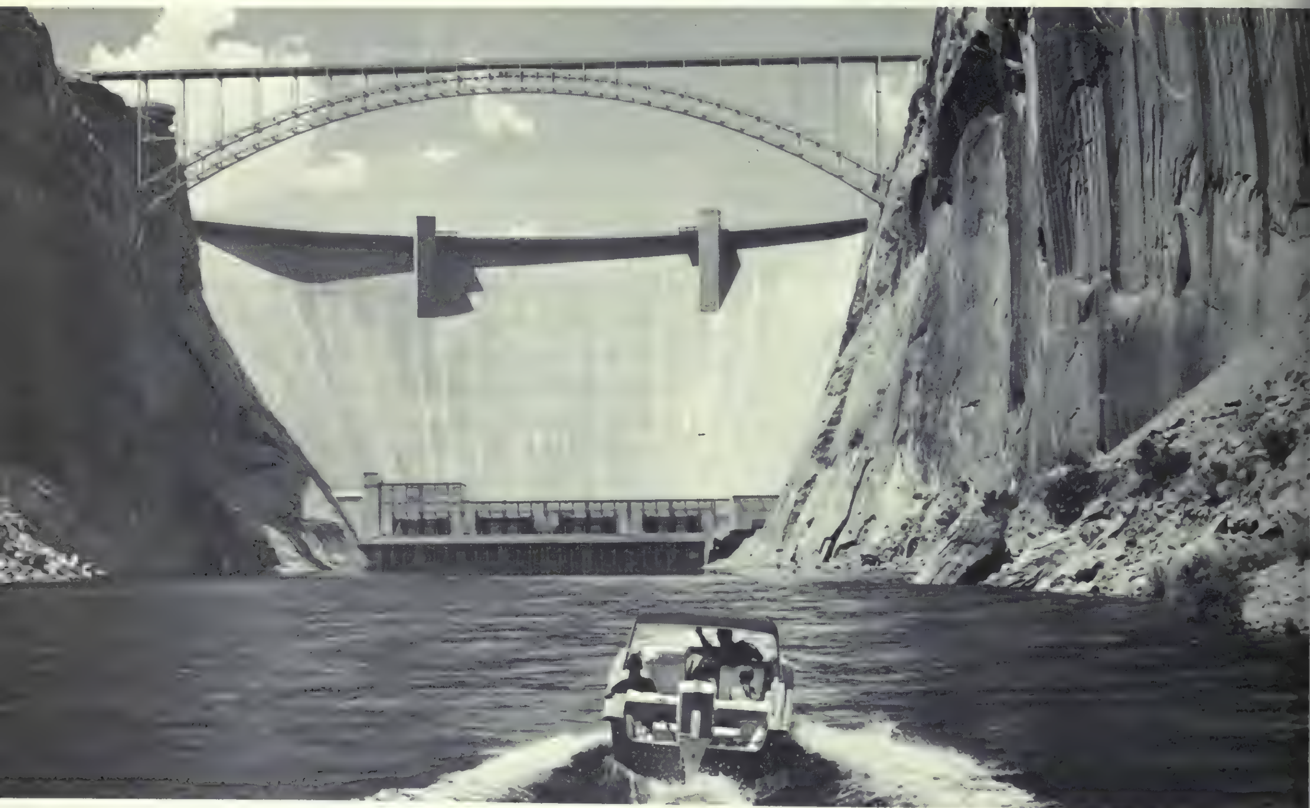
The west side elevator (right side looking downstream) will descend 528 feet into the dam. This is listed as Tour Stop 6, and the trip will take just over 1 minute. Push the button marked "Tour."

Upon leaving the elevator, you will enter one of the dam's many galleries marked Tour Stop 7. Here the 50-degree temperature remains constant year-round.

Galleries are necessary in concrete dams for inspection purposes. In this gallery, over 100 feet of concrete lie between you and Lake Powell.

Number 8 Tour Stop directs the visitor by signs to the powerplant, across a bridge. A grassed area of 86,000 square feet lie between the dam and powerplant, almost 2 full acres. The big manholes you will see are used periodically to inspect expansion joints in the penstocks which are 20 feet below the surface. The water trough at the base of the dam returns drainage water to the river.

Boating below Glen Canyon Dam.



The eight generators in the power generator room, Tour Stop 9, have a combined rating of 950,000 kilowatts. This is enough electricity for a city of about 1½ million people. Generators turn at 150 revolutions per minute, generating power at 13,800 volts.

The generators are driven by reaction turbines, which are connected to the generators by large, vertical steel shafts. The flow of water through the penstocks turns the turbines.

When a rise in the demand for electricity occurs, ne magnetic load against the generator increases, ausing a slight decrease in the speed of the urbines. To keep the turbine and generator rotating at a constant speed, the governor automatically pens the gates, increasing the flow of water nough to bring the speed back to normal and suply the additional power required. The reverse ccurs when power demands drop off.

'iew of Transformers

From outside of the powerplant transformer eck, Tour Stop 10, you can view the massive ransformers which raise the energy from the genrating voltage of 13,800 volts to 230,000 and 45,000 volts for transmission to distant markets. 'he higher voltage decreases transmission line osses.

Each pair of generators feeds power into a bank f three single-phase transformers. Each of the ransformers weigh about 90 tons and includes a eavy metal core and windings surrounded by pecial insulating oil.

Below the powerplant, the river resumes its jourey to the sea. Here, at Tour Stop 11, you see the anyon much the same as Maj. John Wesley 'owell viewed it when he explored it and named it Glen Canyon in 1869.

Glen Canyon Dam has cleared sediment from he river, the water is crystal clear, and rainbow rout thrive in the channel below the dam.

For 15 miles below here, the river winds through ower reaches of Glen Canyon, passes Lees Ferry, nd continues through Marble and Grand Canyons or a distance of 270 miles to reach Hoover Dam, where this same water is again used to generate lectricity.

Beyond Hoover Dam lie a series of Reclamaion reservoirs which furnish water for irrigation etween Arizona and California.

2 at Right

Tour Stop 12 is to your right. On the canyon wall, are many "rock bolts" which prevent rock labs from falling. These bolts are 2 inches in liameter, extent 45 to 75 feet into the canyon wall, nd are cement grouted.

Mounted on the parapet wall is a sample rock olt with the typical anchor and the 14-inch square teel plate, 2 inches thick.

If you do not wish to take the "Hale and Hearty" optional tour from here, Tour Stop 13, proceed to station 14. The tour for the "Hale and Hearty" includes walking down 56 steps to the turbine pit, but riding the elevator back up.

This optional tour will permit you to view the rotating shaft, turbine gate control, governor gallery, and other operating media.

The entire plant is sparkling clean. The generators hum as they produce power from the water rushing down the penstocks. The generators look big from the self-guided tour route, and look even bigger when you see them from below.

The steel shaft is 40 inches in diameter, weighs 79,500 pounds and turns at 150 revolutions per minute. It is connected to the generator above and the turbine wheel below. Water passing through the turbine wheel spins the shaft and generator to which it is connected. About 1,300,000 gallons of water per minute are passing under your feet at this moment.

Water for Page

Here you also see the beginning of the water system for the town of Page. Now there is enough force behind the water stored in Lake Powell that only one pumping station is used to bring the water up to Page.

There are a lot of intriguing pipes, switches, and traps in the floor. If you are able to look under the lid of a trap you can peer into the dungeon-like hole where there are trout and catfish lurking in the water.

The many metal arms at the bottom of the pit are hydraulically operated, and open and close the wicket gate which controls the waterflow through the turbine. Sudden load changes detected by a computer in the Power Operations Center in Montrose, Colo., sending impulses by microwave to the gate controls, may cause rapid operation of the wicket gate.

From this point to the far end of the gallery, or hallway, it is 550 feet. There are eight identical governor units, one for each turbine, spread out down the hallway. The governor units control the speed of the turbines through a high pressure oil system.

Now back to the regular tour. The elevator may stop at floor 3 where you started down the 56 steps; however, remain on the elevator until you reach floor 8, control room.

Stops 14 and 15

Tour Stop 14 gives elevator ride information to those who did not descend the 56 steps, and

number 15 is the powerplant control room. The entire plant is controlled by an operator in the control room.

Working there would be like working in a fish bowl. Every year thousands of visitors at Glen Canyon Dam watch the operator reading the meters and dials on the walls of the circular room.

The operator can observe on the various meters whether or not all mechanisms are operating correctly. This control room is closely linked by microwave radio system to the Power Operations Office in Montrose, Colo., which dispatches power to the various markets. Reading of the generators is controlled by a digital computer in the Montrose office which coordinates power needs, water needs, and power capabilities throughout the Colorado River Storage project

From the outside observation deck, Tour Stop 16, you can obtain some idea of the massiveness of 5-million cubic yards of concrete which stand between you and Lake Powell.

Building Blocks Seen

Glen Canyon Dam was constructed in 26 separate vertical blocks by placing successive 7½-foot layers known as "lifts" on top of each other. You can still see the faint horizontal lines between each 7½-foot layer. The first concrete was placed in June 1960; the dam was topped out in Septembe 1963.

From this point looking downstream, notice th service access tunnel at the bottom of the left can yon wall. This tunnel is 21 feet high and 22 fee wide with a two-lane drive running a length of miles from the canyon rim. The tunnel is used t bring heavy equipment into the powerplant. Worl on the tunnel started at both ends and it took months to build. The tunnel also is a civil defens shelter and could house 20,000 people.

Also on the left side of the observation deck you will see the outlet valves which are 8-foo penstocks designed to discharge water around th powerplant, should the need arise.

Total cost of the Glen Canyon unit, includin the dam, powerplant, access roads, bridge, an facilities at Page, will be about $274 million. Mos of this money will be repaid to the Treasury of th United States by the sale of electricity, over a pe riod of years. Recreation facilities will cost anothe $28 million.

There are 87 people employed by the Burea locally, of which 28 are Page city employees

We hope you have enjoyed your visit to Gle Canyon Dam and Powerplant. The self-guide tour is operated through the combined efforts o the Bureau of Reclamation and the National Par Service. Both are agencies of the Department o the Interior. # # #

NEWS NOTES

Yellowtail Water for Coal Development

Execution of a Bureau of Reclamation contract for sale of 20,000 acre-feet of water annually to the Shell Oil Co., Denver, Colo., from the Yellowtail unit of the Missouri River Basin project has been announced.

The water will be used on the Crow Indian Reservation in Montana for development of coal resources.

The signing of this contract brings the water marketed from the Yellowtail unit to 110,000 acre-feet for exclusive use for coal development on Indian reservations, and the total industrial water marketed to 228,000 acre-feet in Montana, said Commissioner of Reclamation Ellis L. Armstrong.

Commissioner Armstrong expressed pleasure that another water supply contract designed to ai in developing the coal resources of the Cro Reservation had been approved. He also pointe out that the company has agreed in the contrac to comply fully with federal and state law orders and regulations governing air and wate pollution.

Bighorn Lake was created when the Bureau o Reclamation constructed Yellowtail Dam on th Bighorn River. The lake lies in both Montana an Wyoming, and the water is marketed in accordance with the Yellowstone River Compact.

The Shell Oil Co. contract, like those previousl executed, has a 40-year term. However, it will terminate automatically if no water deliveries ar made within 10 years.

Environment of Navajo-Phoenix

Two 500,000-volt Arizona transmission line linking the Navajo Generating Station with th

hoenix area have been designed and routed to ve minimal effect on the natural environment.

The lines will be partially utilized to deliver wer to pump Colorado River water for the Cenal Arizona project.

This information was included in an environental statement draft released last June by the epartment of the Interior.

Prepared by the Bureau of Reclamation, the atement outlines environmental standards which ere used in locating the lines to be followed in eir construction and operation.

Compiled in compliance with the National Enronmental Policy Act, the statement has been ibmitted to the Council on Environmental Qualy. Continued review has been solicited from rious federal, state, and private agencies, inuding conservation and environmental groups.

The draft statement is a cooperative effort inolving the Bureau of Reclamation, private and ublic power suppliers, several federal and state gencies, universities, independent agencies, and idividuals.

One of six recommended by a U.S. Forest Serve team, the route was selected because it would ave the least deleterious environmental and ological effects. The route crosses the Navajo ndian Reservation, the Kaibab and Prescott Naonal Forests, and Bureau of Land Management, ate, and private lands.

Clearing of the 330-foot right-of-way will be one so as to leave as much natural vegetation as ossible. Construction roads will be carefully outed to minimize damage to the vegetation.

All disturbed areas within the National Forests ill be revegetated with plant species designated y the Forest Service. The Soil Conservation Serve will advise the APS (the administrative firm) n species of plants for revegetation of the reainder of the route.

The lines from Cameron to Red Lake will cross pproximately 40 miles of antelope and 10 miles f elk habitat and the remainder of the route rosses 30 miles of deer and 60 miles of upland ame habitats. Since no right-of-way fences are lanned, this will not affect animal movement. Prime food and cover areas will be avoided by onstruction roads and right-of-way alignments.

In areas where the route approaches population oncentrations, the lines will be built behind low ills or on the far side of natural barriers, such as the Agua Fria River. The route bypasses key scenic, recreational and historic locations.

Environmental specialists have been employed by the Arizona Public Service Co., project manager for the line to assist in keeping the environmental impact to a minimum.

The Navajo Generating Station, now under construction near Page in northeastern Arizona about 5 miles south of Lake Powell and the Bureau of Reclamation's Glen Canyon Dam on the Colorado River, will have a capacity of 2.3 million kilowatts.

Copies of the environmental statement for the Navajo-Phoenix Transmission System may be obtained from the Regional Director, Bureau of Reclamation, Post Office Box 427, Boulder City, Nev. 89005, for $1 to cover handling and mailing.

PROPOSED VISITOR CENTER

A final bit of color is added by James M. Muramoto, architect at Denver, Colo. The drawing shows an attractive proposed Grand Coulee Visitor Arrival Center. The structure is planned to be 200 feet square, 40 feet high and ringed on three sides by bleacher-type seating for 300 persons who will be able to view the dam, powerplant, and surrounding country.

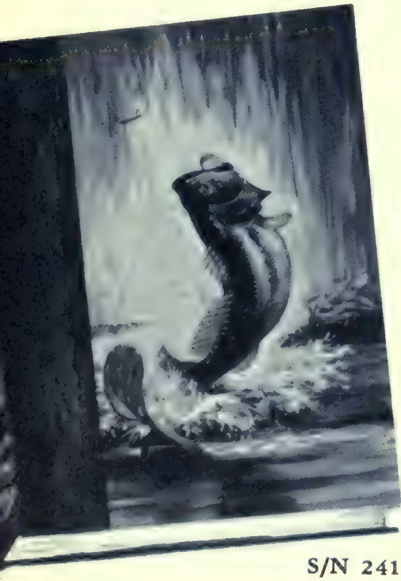
MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6871	Parker-Davis, Ariz.	Apr. 6	Stage 04 additions to Gila substation	United Power & Control Systems, Inc., Seattle, Wash.	$570, 5
DS-6872	Columbia Basin, Wash.	Apr. 9	Isolated-phase bus structures, selector switch and protective equipment assemblies for motor-generator units 7 and 8 at Grand Coulee pumping plant, schedule No. 1.	Hitachi America, Ltd., San Francisco, Calif.	211, 9
DS-6872	Columbia Basin, Wash.	Apr. 9	Two 14,400-volt switchgear assemblies for motor-generator Units 7 and 8 at Grand Coulee pumping plant, schedule No. 2.	Westinghouse Electric Corp., Denver, Colo.	272, 0
DC-6877	Central Valley	May 24	Auburn Dam diversion tunnel	Walsh Western, a division of Guy F. Atkinson Co., South San Francisco, Calif.	5, 114, 0
DC-6879	Pick-Sloan Missouri Basin Program.	June 16	Stage 04 additions to Devils Lake substation	T-B-H Electric Corp., Tacoma, Wash.	229, 8
DC-6880	Central Valley, Calif.	May 19	Earthwork, pipelines and structures for Westlands water distribution system, lateral 7R.	C. R. Fedrick, Inc. and M. M. Sundt Construction Co., Novato, Calif.	2, 838, 4
DC-6883	Central Valley	June 23	Earthwork, pipelines and structures for Westlands water district distribution system, laterals 6 and 8.	C. R. Fedrick, Inc. and M. M. Sundt Construction Co., Novato, Calif.	3, 194, 4
DC-6885	Pick-Sloan Missouri Basin Program.	June 21	Stage 03 additions to Beaver Creek substation	Flora Engineering Co., Denver, Colo.	178, 6
DC-6886	Pick-Sloan Missouri Basin Program.	June 23	Supervisory control building at Casper Center	Reiman-Wuerth Co., Cheyenne, Wyo.	397, 6
DS-6887	Pacific Northwest-Pacific Southwest Intertie, Calif.	June 30	Steel towers for Malin-Round Mountain 500-kilovolt transmission line, items 1, 2, and 3.	Anchor Metals, a Division of All American Industries, Inc., Hurst (Tarrant), Tex.	266, 6
DC-6889	Central Valley	June 30	Corning Canal, Elder Creek siphon protection, Baffled Apron Drop.	L. R. Yegge Co., Los Gatos, Calif.	276, 7
DC-6891	Central Utah	June 29	Jordan aqueduct	S. A. Healy Co., McCook, Ill.	8, 369, 7
		Contract entered into			
DR-12-1	Atmospheric Water Resources Management Program.	Apr. 28	For development of methodology for evaluation and prediction of avalanche hazard in San Juan Mountains area of southwestern Colorado.	The regents of the University of Colorado, Boulder Colo.	254, 3
DR-12-4	Atmospheric Water Resources Management Program.	May 10	Research into effects of additional precipitation on agricultural production, the environment and human society in South Dakota.	South Dakota State University, Brookings, S. Dak.	133, 5
DR-12-9	Atmospheric Water Resources Management Program.	May 25	Research to study the impact of weather modification on the Great Plains portion of eastern Montana.	Montana Water Resources Board, Helena, Mont.	165, 0
DR-12-10	Atmospheric Water Resources Management Program.	May 25	Research and evaluation of the effects of added rainfall during the growing season in North Dakota.	North Dakota State University, Fargo, N. Dak.	125, 0
100C-1146	Columbia Basin, Wash.	Apr. 22	Drains—blocks 201 and 23, schedules No. 1 and 2	John M. Keltch, Inc., Pasco, Wash.	468, 3
100C-1147	Columbia Basin, Wash.	Apr. 6	Buried pipe drains and wasteway bank stabilization, block 77.	M & J, Inc., Moses Lake, Wash.	121, 3
100C-1148	Columbia Basin, Wash.	May 12	Drains, block 86, schedules No. 1 and 2	M & J, Inc., Moses Lake, Wash.	580, 6
100C-1156	Columbia Basin, Wash.	June 25	D15-65-2 drain system and PE51A wasteway, block 15	Ray C. Pickens, Inc., Yakima, Wash.	244, 8
100C-1162	Upper Snake River, Idaho.	June 18	Drilling exploratory wells	Elsing well Drilling, Twin Falls, Idaho.	120, 9
200C-829	Central Valley	June 28	Auburn dam service facility building complex	Kaufman and Reynolds Construction Co., Sacramento, Calif.	459, 9
300C-306	Pacific Northwest-Pacific Southwest Interite, Nev.	Apr. 21	Buried communication cable, Mead Substation to Hoover Dam.	Asteroid Corp., San Diego, Calif.	160, 9
300C-307	Colorado River, front work and levee system.	May 20	Levee construction, R.M. 606.9 to R.M. 608.3, and bankline construction, R.M. 615.8 to R.M. 619.7.	Harmon & Associates, Inc., dba Riverside Construction Co., Riverside, Calif.	197, 0
400C-471	Central Utah	June 30	Block No. 2 drains, Vernal unit	Pollard Inc., West Jordan, Utah.	209, 7
500C-294	Pecos River Basin water salvage, New Mexico-Texas.	May 10	Clearing Pecos River—Pecos area, schedule No. 2	Hudson and Sparks Construction Co., Colorado City, Tex.	119, 8
500C-295	San Juan-Chama, Colorado-New Mexico.	June 30	O & M Building	Giles Construction Co., Alamogordo, N. Mex.	136, 4
700C-750	Pick-Sloan, Missouri Basin Program.	May 71	Courtland Canal subsurface drain 20-3-5	Bushman Construction Co., St. Joseph, Mo.	125, 0
700C-754	Pick-Sloan, Missouri Basin Program.	June 14	Earthwork and structures, Courtland Canal subsurface drain 10-3-5, section 1.	Bushman Construction Co., St. Joseph, Mo.	153, 7
500C-295	San Juan-Chama, Colorado-New Mexico.	June 30	O & M Building	Giles Construction Co., Alamogordo, N. Mex.	136, 4

U.S. GOVERNMENT PRINTING OFFICE:1971 O—429-954

RECENT BID REQUESTS

Project	Description of work or material
Central Valley, CA.	Constructing 28.6 miles of 12- through 72-in.-diameter pipeline with heads varying from 25 through 125 ft; 2 slide-gate structures, and 3 reinforced water screen and recirculating structures; and installing 12 vertical-shaft pumping units with a capacity range of 2.9 to 9.5 cfs with heads up to 28 ft. Westlands Laterals 31-1.5, 32, 36, and 37, near Huron.
Chief Joseph Dam, WA.	Replacing 11 miles of 4- through 16-in. steel pipeline with asbestos-cement pipe, near Brewster.
CO River Storage, CO.	Constructing the 12-ft-diameter, horseshoe-shaped, 1,000-ft-long Crystal Dam diversion tunnel. Twenty miles east of Montrose.
Columbia Basin, WA.	Consturcting concrete foundations; furnishing and erecting steel structures; furnishing and installing three unit substations; installing nine 500-kv power circuit breakers and separately mounted current transformers; furnishing and installing related electrical equipment; stringing about 4 circuit miles of transformer circuits; constructing a 100- by 200-ft reinforced concrete service and warehouse building; and grading, surfacing, and fencing. Grand Coulee 500-kv Switchyard, Cable Spreading Yard, and Transformer Circuits, Stage 01, left abutment area of Grand Coulee Dam.
Do	Work for the installation of Grand Coulee Pumping-Generating Units P/G7 and P/G8 will consist of placing mass concrete, blockout concrete, miscellaneous concrete, concrete architectural finishes and removing some existing concrete; furnishing and installing metalwork; installing spiral case extensions, two pump-turbines, two governors; furnishing and installing piping; furnishing and installing electrical conduit, electrical wires and cables, lighting fixtures, wiring devices, and other electrical equipment; installing a power transformer, isolated-phase bus structures, switchgear, protective equipment, and control equipment for the two generator/motor units. The 50,000-kva geneator/motor units and the 230-kv pipe-type cable system will be furnished and installed under other contracts at Grand Coulee Dam, about 32 miles northeast of Coulee City.
Do	Constructing about 2 miles of Esquatzel Coulee wasteway channel with a base width of 30 ft, south of Eltopia.
Do	Constructing about 2.2 miles of gravel-lined "V" type channel with appurtenant structures for road crossings, to serve as a wasteway for WB38B Lateral, Block 25, east of Mattawa.
Do	One primary outdoor unit substation consisting of two 3-phase, 20,000/26,667-kva, OA/FA, 115—11.95-kva power transformers; and thirteen 11.95-kv airblast circuit breakers and associated devices. Grand Coulee 11.95-kv Switchyard.
Do	Two unit control boards for control of generator/motor Units P/G7 and P/G8. Grand Coulee Pumping-Generating Plant.
Do	Furnishing, installing and testing two 13.8-kv armature windings for existing generators rated at 108,000 kva. Grand Coulee Powerplant.
Do	Control boards for control of the 500-kv switchyard and generator units G19, G20, and G21 at the Grand Coulee Third Powerplant.
Emery County, UT.	Constructing a system of pilot drains, including 1.3 miles of open drains and 1.2 miles of closed pipe drains, near Huntington.
Fryingpan-Arkansas, CO.	Work will consist of constructing the Mt. Elbert Pumped-Storage Powerplant; an inlet-outlet structure and gate structure; and a penstock connecting the gate structure and the plant. The pumped-storage powerplant will be a reinforced concrete structure about 146 by 186 ft in plan and 180 ft high to accommodate one 100-mw reversible generating unit initially and to provide space for a second similar unit to be installed at a later date. One floor is to be supported by a structural-steel framework, and the roof of precast concrete tees. Excavation at the powerplant will include a pit about 150 ft deep and a 100-ft-wide tailrace channel to be armored with riprap. A detour section of State Highway No. 82 is to be constructed and maintained. Construction will include a buried 15-ft-diameter steel penstock about 3,000 ft long and, for a future penstock, about 890 ft of 15-ft-diameter stubs at the reservoir inlet-outlet structure and at the powerplant. The gate structure, to be located at the end of a 120-ft-wide inlet-outlet channel from the reservoir, will be of reinforced concrete and will house two 12.5- by 15-ft-wheel-mounted penstock gates in an 82-ft-high gate shaft. At the top of the gate shaft a reinforced concrete house is to be constructed to house gate hoists and controls. A compacted earth dike is to be constructed around the gate shaft and the inlet-outlet structure. Dewatering the powerplant excavation will be required. Work will also include construction of an access road to the gate structure. At the northwest corner of the lower (eastern) lake of Twin Lakes, about 12 miles south of Leadville.
Do	Furnishing, installing, and testing one vertical-shaft, 3-phase, 60-hertz, hydraulic generator/motor having a generator rating of 105,300 kva at 180 rpm, 11,500 volts, 95 percent power factor, and a synchronous motor rating of 170,000 hp at 180 rpm, 11,500 volts, 95 percent power factor. Mt. Elbert Pumped-Storage Powerplant.
Kendrick & Pick-Sloan MBP, WY.	Four each auxiliary control cubicles; one lot each of unmounted switchboard equipment; and two each unmounted, 125-volt, d-c, solid-state, undervoltage relays. All for Alcova and Glendo Powerplants.
Pick-Sloan MBP, KS.	Constructing about 2.1 miles of 6- and 8-in Courtland 17-3-5 subsurface drains varying in depth to 11 ft, near Courtland.
Pick-Sloan MBP, MT.	Preparing about 7,300 lin ft of Helena Valley Canal subgrade and installing asphaltic membrane or polyvinyl chloride membrane lining with gravelly material cover. The canal bottom width is 12 ft., near Helena.
Pick-Sloan MBP, NE.	Constructing Stage 02 additions to Grand Island Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; relocating steel structures; furnishing and installing one 345-kv power circuit breaker and related electrical equipment; and relocating one 345-kv power circuit breaker and related electrical equipment. About 3 miles east of Grand Island.
Do	Furnishing and placing about 2,500 steel jacks along the banks in Frenchman Creek. Between Enders Dam and Palisade.
Do	Selective clearing of trees immediately adjacent to streambanks; removing logs and debris from creek channel; and channel widening on restricted waterway openings to alleviate overbank flooding in selected reaches of Frenchman Creek, 3d section. Between Enders Dam and Palisade.
Pick-Sloan MBP, SD.	Constructing Stage 08 additions to Sioux Falls Substation which will consist of constructing concrete foundations; furnishing and erecting steel structures; installing one 230-kv circuit breaker; furnishing and installing two 115-kv circuit breakers; furnishing and installing associated electrical equipment; and modifying two 230-kv transmission line approach spans, near Sioux Falls.
Pick-Sloan MBP, WY.	Constructing about 2 miles of double-circuit and 4 miles of single-circuit, 3-phase, 115-kv Cheyenne-Archer North and Cheyenne-Archer South Transmission Lines and constructing new structures for the single-circuit, 3-phase, 115-kv wood-pole Archer-Gering Transmission Line. The work will consist of dismantling and salvaging 8 circuit miles of existing Cheyenne-Archer North and South Transmission Lines; furnishing and erecting wood-pole structures; constructing embankments; constructing concrete foundations for steel towers; relocating four existing and furnishing and erecting eight new steel transmission line towers; fencing and gravel surfacing 11 structure sites; and furnishing and stringing three and six 477-Mcm, ACSR conductors and two steel strand overhead ground wires. About 2 miles southeast of Cheyenne.
Do	Furnishing and testing programmable master supervisory control equipment for the control of seven North Platte Area powerplants from Casper Control Center. The master terminal is to be provided with color cathode ray tubes utilizing one-line diagrams.
Teton Basin, ID.	Constructing a zoned earth and rock fill dam embankment about 3,050 ft long at the crest with a height of about 305 ft; a power-pumping plant structure consisting of a belowground, cast-in-place, reinforced concrete substructure about 189 ft long, 87 ft wide, and 54 ft deep; a superstructure about 160 ft long, 57 ft wide, and 37 ft high to be of structural-steel and precast concrete panels. Three 10-mw generating units will be housed within this structure, two of which will be installed in the completion contract and the other to be installed at a later date. The pumping plant portion of this structure will house six motor-driven pumping units with a combined pumping capacity of 70 cfs. Constructing a reinforced concrete inlet structure, about 24 by 55 by 50 ft deep; a river outlet works which will supply water to the river, power and pumping plant; a canal outlet works consisting of an intake structure, a 13-ft 6-in. diameter upstream tunnel, a gate chamber and a shaft house, a 13-ft 6-in. diameter downstream tunnel with steel liner, a steel outlet pipe varying in diameter from 13 ft 6 in. to 9 ft 0 in. with branches and gates, and a stilling basin; a tailrace channel and retaining walls; a 42-in.-diameter pump discharge line 900 ft long and maximum head of 375 ft, to be either precast pressure pipe or lined and coated steel pipe; a canal outlet works control structure, and a 72-in.-diameter pipeline 7,400 ft long with a maximum head of 125 ft; an auxiliary outlet works composed of an intake structure, a 6-ft-diameter upstream tunnel; a gate chamber and adit, and a 7-ft 3-in. diameter downstream tunnel; a spillway which includes an inlet structure with three 20-ft 8-in. by 15-ft 6-in. radial gates, a chute, and a stilling basin; and about 1,800 ft of roadwork. The superstructure portion of the combined gate control and warehouse structure, about 98 by 48 by 15 ft high, will be of structural-steel precast concrete panels and concrete masonry interior walls. This structure will house the gate controls for the river outlet works and also will provide about 3,400 sq ft of garage and warehouse storage area. Teton Dam and Power and Pumping Plant, on the Teton River, about 15 miles by road southwest of St. Anthony.
Upper CO River Storage, CO-WY.	Constructing about 38 miles of single-circuit, wood-pole and 5 miles of double-circuit, steel-tower, 3-phase, Archer-Weld (Stage I) 230-kv transmission line. Work will consist of furnishing and erecting wood pole structures; constructing foundations; furnishing and erecting steel towers; furnishing and stringing three 954-Mcm, ACSR 45/7 conductors, and two ⅜-in. steel-strand overhead ground wires on the wood-pole section; furnishing and stringing six 954-Mcm, ACSR 45/7 conductors and two ⅜-in. steel-strand overhead ground wires on the steel-tower section; swinging several spans over to the double-circuit section of line and after energizing the new construction, salvaging 5 miles of 115-kv wood-pole transmission line. Extending from Archer Substation, near Cheyenne, Wyo., to proposed Ault Substation site, near Ault.



November 1

RECLAMATION

era

A WATER REVIEW QUARTERL

November 1971 Vol. 57 No. 4

RECLAMATION era

Kathleen Wood Loveless, Editor

CONTENTS

COVER. Youth Conservation Corpsman Mike Real and supervisor Ray Holley discuss plans for finishing a rest shelter at the end of the newly extended Causey Narrows Trail, East Canyon Reservoir, Utah. Photo courtesy *Ogden Standard Examiner.*

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Striking a Balance

Concern over the natural environment is vital and good, but we must also be concerned about maintaining our standard of living—fulfilling our basic needs. In order to achieve these two goals, we must find a point at which we can reconcile the differences between these two ideologies.

Many believe we are faced with a choice between only the preservationists and the exploiters of the natural environment. I don't believe these are the alternatives.

Good environment is not guaranteed if man leaves nature in its virgin state. Since "good environment" is a value judgment made by man, environment which harms him or does not allow him to live a productive life cannot be considered good. Water, controlled and put to use, does contribute to the betterment of man and in most instances, also enhances the natural environment. The West, where water is life, is replete with examples.

The purist preservationists are raising their voices in support of a philosophy to preserve all things in nature—as nature created them. They are overlooking the fact that man, as well as the animals, the landscape, the vegetation and all the natural resources, has a place in the environment of the earth. Man cannot long exist unless he manages the resources of nature and puts them to use. A good environment must include a balance between the earth in its natural state and the earth altered by man to make the land a productive and friendly place on which he can live.

Just as nature is constantly changing, so are the ecological patterns of life. For this reason man cannot avoid making changes in the natural environment as he moves about and manages his existence on this planet. A quality environment in harmony with nature is not a luxury that we may afford, it is a necessity that we must afford. The key is good management and sound husbandry of natural resources.

There is no question that during the pioneering of our country the users depleted the resources. But America is no longer a neophyte country latticed with nothing but foottrails and abounding with natural resources.

We must be realists, who agree that the need to manage the natural environment in such a way as to protect it is not an end unto itself, but is essential and justified to the extent that it is beneficial to people and to the preservation of the biosphere.

It is a realistic position that will allow us to meet a common goal of achieving a good environment for man and nature.

ELLIS L. ARMSTRONG
Commissioner of Reclamatio

THE LIMITLESS ENERGIES OF AMERICAN YOUTH

Cleanup of unsightly areas is one of the projects undertaken by corpsmen from the Big Bend Youth Conservation Corps.

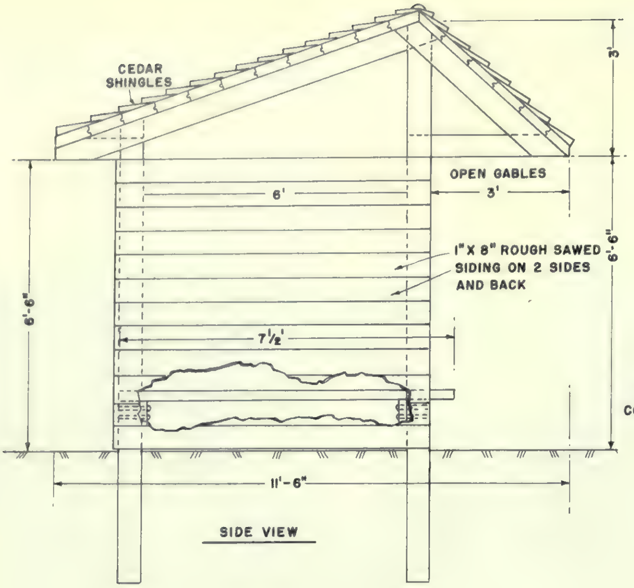
THROUGHOUT the mountains, forests, and other public land areas of the United States, new camping shelters are springing up; trails are being built; badly weathered fences are being repaired and new ones built; livestock water facilities are being developed; and even bullrush and other waterfowl food are being planted. This is not the work of hundreds of husky men, nor has it taken years to complete. Instead, it is the work of 2,200 young men and women between the ages of 15 and 18 who accomplished all this and more in just 8 weeks.

Nixon Authorizes YCC

These hard workers are members of the Youth Conservation Corps—YCC. On August 13, 1970, President Nixon signed Public Law 91–378, authorizing up to \$3.5 million annually to establish within the Departments of the Interior and of Agriculture a joint 3-year pilot program designated as the Youth Conservation Corps.

Of the \$3.5 million authorized, \$2.5 million has

Corpsmembers work to improve Reclamation projects. Here a fence is being installed on Reclamation lands administered by the Wash. State Game Dept.



HIGH HUT
(REST SHELTER)
CONSTRUCTED BY YCC

been appropriated, with $1.25 million allocated as each Department's portion of the program. These funding levels permitted employment of 1,100 youth by each Department during the 8-week periods which began the first of last summer.

Purpose of YCC

Both Departments have manual work which needs to be accomplished and both Departments realize the tremendous potential existing in American youths during the summer months. It was therefore decided that by gainfully employing these young people the Departments, as well as the students, would benefit.

By placing these youths in the healthful outdoors, it afforded the Bureau of Reclamation, and other agencies administering the national park system, national forests, national wildlife refuges, and other Federal land and water areas the opportunity to complete many needed projects. At the same time, it provided the young people an opportunity to earn money to further their education and to gain an understanding and appreciation of the nation's natural environment and heritage.

Participants

The YCC is comprised of young men and women who are permanent residents of the United States, its territories, or possessions. The girls work right alongside the boys and very seldom complain about the hard work. In fact, after being asked if she minded digging post holes, Bernice Amoriz of Whittier, Calif., replied, "No, not at all! But, it does get just a little tough when we have to dig through rock."

The Corps is open to youth of all social, economic, and racial classifications. Men and women all work together to improve our nation's natural resources.

Selection of Camp Sites

The selection of camp sites is made on the basis of two considerations: (1) availability of existing facilities that can be readied for YCC occupancy with a minimum expenditure of time, work, and money; and (2) the potential of the area for developing worthwhile conservation work projects at or near YCC camp sites.

Over 60 residential and nonresidential camps were established throughout the nation and, in just the short 2-months operating time, accomplishments far exceeded expectations. For example, at the Bureau of Reclamation camp at Big Bend Community College, Moses Lake, Wash., a cleanup campaign scheduled to take up to 2 weeks to complete was accomplished by 50 YCC workers in just 3 days.

In addition to separate residential camps for the young men and women there were numerous coeducational camps. The residential camps housed 11 to 50 Corps members. Facilities ranged from tents and rough bunkhouses to large barrack-type buildings and college dormitories. In some in-

tances, small groups even occupied remote ranger tations.

Nonresidential camps permitted local youths to work on conservation projects during the day and e transported home at night.

The program also allowed a few qualified young eople to work singly or in small groups with proessional foresters, park rangers, engineers, and ther scientific and professional personnel enaged in a variety of conservation tasks.

'ouths' Earnings

Participants in the residential programs were aid a fixed sum for the 8-week tour of duty, mounting to $292 take-home pay after Social ecurity deductions. They also received free room nd board. Those who participated in the nonresiential program receive a slightly higher rate of ay, in lieu of room and board. On learning that Corps members would actually be paid for their work, one youth commented, "You mean we get aid for all that fun?"

Vhat Is Fun?

What that young man referred to as fun is more often described by adults as hard labor. Stream banks were cleared, trails were built, fish hatcheries were tended, park facilities were constructed, trees were planted, even experimental rabbit nests were prepared for rabbits who had lost their homes when they caved in.

Charles C. Butler, Chief, Youth Conservation Programs for Reclamation, made this comment about the young workers, "They accomplished three times as much work as we had anticipated. Every Corps member was willing to work at all types of projects."

Herbert E. Martin, Project Manager of the National Park Service Harpers Ferry YCC Camp in West Virginia, was as pleasantly surprised as Butler, "After just the first week, we realized that the projects we programed for the participants greatly understimated their potential. The energies of these young people know no bounds."

All work projects were oriented and executed to give the Corps members an understanding of *what* they were doing, *why* they were doing it, *how* it was to be accomplished, the part it played in the overall plan for the area, and the environmental

hese YCC members take time out for the lunch they prepared early that morning.

This corpsman protects the roof of a shelter from further leakage.

factors considered. The effectiveness was evidenced by the comment made by Jenny Smith, a Corpswoman at the Harpers Ferry YCC Camp, "I'm now more conscious of the polution and conservation problems facing us today."

YCC participants were given the opportunity to accept all the responsibility they could assume and they were given every opportunity to participate in the planning of new work projects.

Plenty of Discipline

Perhaps one of the most important features of the YCC program is that it places emphasis on self-discipline. Youths are expected to conduc themselves in an appropriate manner while ful filling their tasks.

Part of the discipline is learning respect fo safety rules. Each day these young people wer confronted with various potential hazards, but b following the safety rules set by themselves, cam staff members, and the camp director, many dis asters were averted. Not a single disabling acciden occurred during the 8 weeks of operation.

Public and Private Nonprofit Organizations

The law which established YCC provided tha the Secretaries of Interior and Agriculture ma "contract with any public agency or organizatio or any private nonprofit organization which ha been in existence for at least 5 years for the opera tion of any Youth Conservation Corps project. A number of such agreements were negotiated fo the operation of YCC camps on a contract basi during the 1971 summer season.

The Bureau of Reclamation entered into fou such contracts with very successful results. Al work projects undertaken by the YCC, regardles of contract or noncontract operations, had to b accomplished on lands and waters administere by either Department.

Contrasts With Job Corps

YCC should not be confused with the Job Corp Civilian Conservation Center program or th Neighborhood Youth Corps program.

The objective of the Job Corps Civilian Con servation Center is to provide intensive program of basic education, vocational training, work ex perience, counseling, and other activities for th Nation's disadvantaged youth on a year-roun basis. Such centers are located where outdoor co servation work experience can be oriented towar high-level skills training in vocations having pr determined employment opportunities.

The emphasis of the Neighborhood Youth Corp is to provide jobs for economically disadvantage youth at all levels of government—local, state, an federal.

The Youth Conservation Corps serves youn men and women of *all* social, racial, and econom backgrounds by providing them with gainful em ployment, while at the same time accomplishin

Corpsmembers from both sexes prepare stones to be used in building a drinking fountain at Summer Falls, Wash.

valuable conservation work to improve the environmental quality of our public land and water resources.

YCC Eligibility Requirements

Aside from geographic criteria, the Interior-Agriculture Task Force limited selection of candidates for the YCC to those who met the following requirements:

- Have attained age 15, but not yet 19.
- Are permanent residents of the United States, its territories or possessions.
- Have a genuine interest in conservation, and in learning about the development and maintenance of the nation's natural environment.
- Have no history of serious criminal or other antisocial behavior that would jeopardize the youth's safety or that of others.
- Are recommended by school principal, guidance counselor, teacher, or other responsible adult(s) other than parent(s).
- Are physically qualified to participate fully in the various work and training projects of the YCC camp program.
- Have parental or legal guardian consent to enroll in the program. Consent form includes statement that parent or guardian is responsible for non-work related medical expenses due to injury or illness.
- Have or can obtain a work permit as required under the laws of the state in which enrollee programs will be carried out.
- Have a Social Security number prior to entrance into program.

All YCC members were required to provide themselves with the proper type and amount of work clothing to meet local climatic conditions.

High Huts

Secretary of the Interior Rogers C. B. Morton asked five Bureaus of the Department to suggest specific areas where a few "high hut" shelters could be built by the YCC as demonstration projects. The project was successfully carried out by the young workers.

"High huts" are simple, rustic structures, usually constructed of material native to the site in which they are located. These primitive shelters are located where campers and backpacking hikers can find temporary shelter from the elements. They

are designed to be open on at least one side.

They are fairly common in alpine areas in Europe, hence the name "high huts." Some have been built in past years along parts of the Appalachian Trail and in a few other places in this country. However, there has been no Federal program specifically to provide more of these simple shelters, although the number of back-country hikers has grown enormously.

Secretary Morton suggested that "high huts" be constructed near recreation areas, along trails and rivers in the back country, and near—but not inside—areas officially designated as wilderness, where no permanent roads or structures are permitted.

These shelters are designed to utilize fully materials native to their area so that they will blend well with their surroundings. They are simple in design so that they can be low cost, and easily and quickly constructed.

Different types of construction adapted to local conditions can be used. For example, a high peaked "A-frame" design would be appropriate in areas where winter snows are heavy, while marshy or swampy spots will require an entirely different structure. However, the most common design is that shown in the diagram on this page.

There is nothing plush or sophisticated about these structures. They are for people who enjoy a rugged back-country kind of outdoor experience in contrast to the comforts preferred by so many tourists.

YCC workers constructed a number of high huts during the summer of 1971, and plans are being made to construct even more next summer.

Bureau of Reclamation's Participation

The Bureau played a large part in the planning, development, and operation of the YCC program. Reclamation representatives served on the Departmental Task Force which developed rules and regulations for operation of the camps. They also developed a model contract for camp operations. A YCC administrative services unit was set up in the Bureau's Salt Lake City regional office to handle financial and personnel operations for all agencies of the Department of the Interior engaged in YCC activities.

Four contract camps were run by the Bureau: Children and Youth Services, Inc., Uinta Mountains, Utah; Big Bend Community College, Moses Lake, Wash.; Opportunities for Youth, Inc., Koos Camp, Koosharem, Utah; and Weber State College, Ogden, Utah.

Each of these camps has helped to promote a three-fold goal: (1) to work on conservation projects needed to improve the quality of public land and water areas; (2) gainfully to employ our nation's youth for the summer; and (3) to build a reserve of environmentally trained young citizens, knowledgeable of their country's irreplaceable heritage of natural and historic resources and of their own place in the ecological cycle.

Children & Youth Services, Inc.

This residential camp opened its doors on June 21, 1971, to 12 girls and 38 fellows. The physical facilities consisted of dormitories for the young workers, staff quarters, cafeteria, recreation rooms, and outdoor recreation areas. These YCC workers proved to be invaluable to the Strawberry Forest Service District when they helped plant 7,000 trees which, otherwise, would have been lost.

Said one young man of the job, "I never dreamed I could work so hard and like it so much." Enrollees also helped to develop camp facilities, including installation of tables and outdoor cooking grills, as well as working on numerous other resource development projects. All work greatly helped the nation's recreation and environmental program.

Big Bend Community College

One of the interesting projects completed by Big Bend's youths was the installing of 200 cottontail rabbit nests underground in the sand dunes near the Potholes Reservoir. These furry creatures were having difficulty surviving when their homes collapsed in the sand. Access to the nests was through a concrete pipe tunnel.

The Big Bend camp at Moses Lake, Wash. housed 25 boys and 25 girls in college dormitories during the 8-week period. They spent 30 hours a week on field projects and participated in 10 hours of environmental study. There were athletic and recreational activities in the evening and other off-duty hours.

Other work completed by YCC workers included construction of 16 miles of desert wildlife trails in central Washington, installation of information and route direction signs, building of fences and foot bridges, repairing picnic and camping facilities and refurbishing irrigation structures on the Columbia Basin project.

Commissioner Armstrong watches youths refurbish an outdoor sign during the Commissioner's visit to the YCC Camp at Moses Lake, Wash.

One phase of the recreational activities included an emblem-designing contest. The Big Bend emblem was worn on T-shirts and included the words: "YCC, Big Bend College 1971, U.S. Bureau of Reclamation." Enrollees completely planned and paid for this themselves.

Opportunities for Youth, Inc., Koos Camp

A 3-day "survival trip" on the desert was truly one of the unforgettable experiences at the Koos Camp in Utah. The 25 boys and 25 girls went in shifts on this test-of-resistance trek. The enrollees were not allowed any food and only minimal water. They camped in the wilds at night and walked many miles during the day with temperatures often exceeding 120°. The purpose was to teach each Corps member to survive under extreme physical and mental pressure.

Paul Sparks, a participant on the survival trip, explained that it was one of the most worthwhile experiences they had. "Our true test of courage came when two girls got lost and we looked for them for 7½ hours—7½ hours of yelling our heads off and praying our heads off," said Sparks, "but we found them and they were all right."

Working as a YCC corpsman taught Bill Sermeno "to work harder at a task and to continue trying even if the task becomes almost impossible to complete."

The girls were just as enthusiastic as the boys were about the experience. Lorri Wright expressed her feelings about the jobs, "The work I do is sometimes hard, but not too hard for me. Being a girl in this program is no different from being a boy. For the most part, we are equal workers."

Among the work projects most enjoyed by the enrollees was the construction of Sand Ledges, a winter recreation area designed for snowmobiling and sledding. These youths also built bird guzzlers, receptacles which hold stored water; worked on antelope range gates; erected numerous fences; developed stock watering facilities and many other projects for environmental improvement.

Weber State College Camp

Unlike the three other Bureau YCC camps the Weber State College camp was not coeducational. Fifty males lived together at the school dormitories without the pleasure or disadvantage of having female coworkers. These fellows developed the camp and picnic areas near the shore of East Canyon Reservoir. They installed tables, outdoor cooking grills, and parking barriers; constructed foot trails; and left a well-groomed area to enhance the environment.

They worked four 6-hour days per week while Friday was set aside for environmental training. During the summer, these YCC enrollees constructed one high hut. The Forest Service later erected signs for the hut and the trails to indicate that these were made by YCC workers at Weber State College. The Utah State Parks Rangers were so impressed with the enrollees' work that they hosted a barbeque for the Corps members.

Beyond Wildest Expectation

Davis McBride, Project Manager of all four Bureau of Reclamation YCC camps, summed up the results of the initial summer operations, "This is the most successful program I have ever been involved in. As new as it is, it is surprising that it is such a success—it has gone beyond our wildest expectations." # # #

A DREAM COME TRUE

Here are only a few of the thousands of rolls of man-made fibers that are fed through the plastic tubes shown at the top of the photo to large tufting machines.

FROM wall-to-wall, to room-size, to shag-mat, carpeting has become a very important furnishing in American Homes today. In colors ranging from brilliant reds to subdued beiges, carpeting may change the entire mood of a room by just a color change. Its texture also offers much choice; the velvety quality of closely sheared pile can transform a rumpus room into an elegant dining area; even the popular indoor-outdoor carpeting can favorably alter a patio or kitchen.

A Prime User of Water

With fiber content including blends of wool, cotton, nylon (and a myriad of other man-made fibers), carpeting is a product of numerous refining processes which use millions of gallons of water annually. Besides using great quantities of water to prepare the fibers, approximately 900,000 gallons of water per day are used to produce 800,000 square yards of carpeting per month.

The Sequoyah Carpet Mills with plants located in Anadarko and Davis, Okla., is one industry which utilizes water supplied by Bureau of Reclamation projects. The plant at Davis, located approximately 75 miles south of Oklahoma City, receives its water via aqueduct from the Bureau's Lake of the Arbuckles, impounded by the Arbuckle Dam. And the two facilities located at Anadarko are supplied water by the Bureau's Fort Cobb project.

The Fulfillment of a Dream

Sequoyah Carpet Mills began as a dream in the mind of a wistful young man named Don J. Greve, just 9 years ago. Formerly a Methodist missionary worker, Mr. Greve had the opportunity to see the abject poverty in which Oklahoma Indians were living.

Many of these people had never held a job for more than 6 months at a time. They were untrained and unskilled, and possessed little incentive to improve their position. As a group, Indians still are the most neglected people in our entire economy; at one time, 78 percent of the Indians in the Anadarko area were jobless. Greve's greatest desire was to help them create a better life for themselves, hence disproving the usual cliches about the unemployed:

They are said to be lazy. Absenteeism at Sequoyah is less than three-tenths of one percent.

They are said to be untrainable. Workers at Sequoyah had never even seen a carpet mill; yet they acquired new skills so rapidly that, in a highly competitive industry, their products racked up more than $6 million in sales the first year.

They are said to lack ambition. Sequoyah's men earned as many as four raises the first year.

They are said to be poor money managers. Given their choice of profit-sharing plans, they passed up extra money now for pensions later.

The Sequoyah Carpet Mills certainly was the

After being woven, the carpeting is dyed in vats containing 5,000 gallons of solution made with Reclamation water.

Tufting machines require constant attention to preclude flaws in the finished product.

Folds of tufted or "shag" carpeting dry in the huge Sequoyah Mills.

442-270 O - 71 - 2

answer to the problem of how to help these Indians create a better life for themselves. With their keen sight and nimble fingers, they are naturally suited for the type of work required in the mills.

Financing the Dream

Greve estimated that $750,000 was needed to finance the operation. Unfortunately, when he revealed to potential investors that he planned to hire Indians, Blacks, and other individuals who had never had a chance for steady work, most "ran from the project like scared rabbits."

After a year of seeking new investors, Greve finally raised the money: a loan of $390,000 from the Federal Government's Area Redevelopment Administration; $60,000 from a local electric cooperative; $60,000 from a state industrial-loan agency; still another $60,000 from the merchants and townfolk of Anadarko; and the final $200,000 from himself; Charles Purcell, a close friend; and Stanford D. Lee, a former executive of a carpet-manufacturing firm.

The Dream Becomes a Reality

With financial matters arranged, the company purchased a 13-acre site, upon which it erected the first factory building. An additional $350,000 was then spent for needed equipment. Within a few short months, the Sequoyah project began operating on November 17, 1963, and became an obvious success. In fact, it was cited by Luther Hodges, then Secretary of Commerce, as a fine example of government-business cooperation.

Now that the new mill was a dream-come-true, Greve began preparing for its expansion and for additional plants.

Number 2 in Anadarko began production in July 1967. Both Anadarko plants now employ about 500 people and, under ideal conditions, produce approximately 1,800,000 square yards of carpet per month.

The third mill at Pawhuska began production in February of 1969. It employs 95 people and has produced as much as 1,200,000 square yards of carpeting in one month.

The fourth mill, completed at Davis in the spring of 1969, now employs 224 people. Combined, the two plants at Anadarko and the one at Davis currently produce 500,000 square yards of carpeting per week.

Mammoth machines convey carpet through the inspection and trimming station.

In spite of constant attention, mistakes do occur. But with this hand machine, repairs are easily made.

After being cut, these carpet samples are supplied to dealers who sell the Sequoyah line.

Prior to shipping, rolls are coded according to width, color, and design, then they are wrapped and stored.

Sequoyah Carpet Mills leases a fleet of 75 tractor-trailer rigs for the purpose of delivering their product to all 48 contiguous states.

The fifth plant in Oklahoma, recently completed, is the largest commercial carpet plant in the world.

And finally, the Watonga plant, the first yarn-spinning plant for Sequoyah Industries is also the first volume long-staple, carpet yarn-spinning system in Oklahoma.

Sequoyah Is a Success

The faith Greve, the townspeople of Anadarko, and the many other supporters had in the carpet mill dream was repaid by the success of the industry. In Sequoyah's first year, sales hit the level which had been the goal for the third year. Plant space was doubled, then more than doubled, and one shift was expanded to three. Initially, the plant parking lot was merely an expanse of open ground, with a few cars scattered here and there; now, a latecomer must scout diligently for an empty space.

Sequoyah Industries have now even entered the home furnishing field, including upholstered furniture and bedding. Sequoyah Transportation Co., Inc. is still another part of the flourishing Sequoyah Industries.

Don Greve, Chairman of the Board, had this to say about the Bureau of Reclamation's assist:

"We know the importance of large amounts of good quality water to the production of Sequoyah carpet; over 3½ million gallons a day are used in our manufacturing facilities.

"It was water from the Fort Cobb, Okla., reservoir which made possible the establishment of our first carpet mill in Anadarko, Okla. Its success brought construction of a second mill and additional employment.

"Water from Lake Arbuckle was one of the determining factors in the location of our newest and largest carpet mill in Davis, Oklahoma.

"The importance of water to the success of our industry, as well as bringing employment opportunities to these rural areas of Oklahoma, is obvious.

"Appreciation of this water value is being shown by Sequoyah's determined, successful effort to control plant wastes. We share in the deep appreciation of environmental control, knowing the great importance water holds for our company and for the communities we are in." # # #

Six years ago the Madison Substation had very little community appeal . . .

But after "community styling," the "eye-sore" was replaced by a well-planned, attractive substation.

In Just Six Short Years

by MIKE REYNOLDS, Editor
***The Current*, Phoenix, Arizona**

COMMUNITY styling is 6 years old—the Salt River project's beautification program began just 6 short years ago. Since that time, the SRP has installed over 200 water turnout structures having inlaid rock facings, erected hundreds of new street lights, built over 150 miles of transmission lines with many of the towers being modern single pole types, and installed more than 500 cable miles of underground distribution lines to serve over 20,000 customers. During the same period, the project has constructed or rebuilt 19 distribution substations which are "Community Styled."

The transition of Madison Substation shows the evolution from old style substations with high superstructures and chain-link fences. Old black poles with crossarms for high voltage lines have been replaced by modern grey ones without crossarms and 12,000-volt distribution lines have been removed and placed underground. Chain-link fences have been replaced with decorative enclosures designed to blend into the architecture of the area: oleander hedges have been replaced with well designed landscaping.

It's all part of the project's effort to make the valley a more attractive place to live. # # #

WATER Quiz

1. Is the *new* source of water found in western Colorado which may eventually yield an additional 750,000 acre-feet of water annually a—
    a. high-pressure artesian well?
    b. geothermal temperature hole?
    c. natural geyser?

2. In what phase of research conducted by the Bureau of Reclamation is this instrument used?

3. Arrange these four states in the order of their total irrigated acreage—smallest to greatest:
    a. Alabama
    b. Alaska
    c. Arizona
    d. Arkansas

4. How may a stream's acidity or alkalinity be determined?

5. Accompanying the increased time for recreation is an increase in number and variety of recreational machines and equipment. What is the name of this water vehicle and how does it differ from its snow counterpart?

ANSWERS: (1) a; (2) weather modification, weather balloon detection (the instrument is a target tracking radar); (3) B, A, C, D; (4) By taking a pH test of the water; (5) Sea-doo—differs from a Ski-doo since it has a boat hull instead of skis.

Region 7 Launches Program To Reduce Subsurface Drain Costs

by WILLIAM A. LIDSTER, Regional Drainage Engineer, Denver, Colo.

ONE of the greatest domestic problems facing our country is saving our soil and water. With the growing amount of subsurface drainage required in the irrigated areas of the western United States, coupled with the continuing rise in construction cost and the dwindling farm prices, it is imperatve to find cheaper and quicker methods of constructing subsurface drains to protect a precious commodity—our productive soils.

To illustrate the importance of this program, we estimate 23,500 miles of subsurface drains will be required by the year 2000 to drain lands brought under irrigation in the 17 Western States. Present data show that construction cost of all drains may average $25,000 per mile. On this basis, the total cost of 23,500 miles will add up to an astonishing $587,500,000.

The figures for miles of drain pipe beyond the year 2000 are only rough reconnaissance estimates, but they are even more astounding. For instance, in the glacial till lands of North Dakota, South Dakota, and Montana, approximately 10,000,000 acres of irrigable land will require 500,000 miles of drains costing $12.5 billion.

It must be kept in mind these are only estimates, but they give a realistic picture of drainage needs and costs.

How Are Bureau Drains Constructed?

Most Bureau of Reclamation subsurface drains are constructed of clay or concrete pipe in 2- to 4-foot lengths with a 1⅛-inch space between each joint to allow ground water to enter the pipe.

A continuous uncompacted 4-inch gravel envelope is placed about the pipe to stabilize the base material and to provide a permeable path for water to move into the open joints between each pipe. A gravel envelope of less than 4 inches thick would be sufficient, but with present construction methods the physical placing of the envelope material uniformly to smaller thickness is difficult.

We presently specify a minimum trench width of 24 inches or just enough width for a man to work in the trench.

The depth of subsurface drains is controlled by several things, such as the outlet elevation, the general topography of the area, and the position of the more permeable strata in the soil profile. Assuming all things to be equal, we normally strive to place our drains at a minimum depth of 6 feet. In our area, the optimum depth varies from 9 to 10 feet. This depth was derived by economic evaluation which will be discussed later.

What Are Drains Costing?

In any drainage installation there may be special costs associated with a particular location such as railroad and major highway crossings. However, this cost analysis is restricted to the basic elements of a drain; namely:

1. Trench excavation and backfill
2. Gravel envelope for drain
3. Furnishing and installing drain pipe
4. Excavation and backfill for manholes
5. Furnishing and constructing manholes.

igure 1. Garwood Buckeye Model 4–11 self-propelled trencher and pipe-laying machine.

Prices the Bureau has paid for these elements of lrainage work in Regions 1, 4, 6, and 7 are shown n Figure 3. Figure 4 shows a comparison of the veighted average prices among Regions. The difiiculties in construction and the number of conractors bidding on a particular job will naturally nfluence the bid prices. Although each Region has ts own construction problems, these are difficult o put into general classes and will tend to offset ach other. Therefore, this article will assume they re equal for all Regions. Region 1 enjoys having he largest number of contractors bid on its jobs. Regions 4 and 6 usually have three or four bids on ach of their jobs, while Region 7 may obtain only wo bids. The average cost per mile of drains, calulated from recent bids, was found to be as ollows:

Region	*Average cost per mile*
	$16, 400
	32, 000
	23, 100
	32, 000

Assuming Region 1 as a base for cost comparion, drains in Region 6 are costing about $1\frac{1}{2}$ times he base, while water users in Regions 4 and 7 are aying almost twice this base price.

What Are We Doing About It?

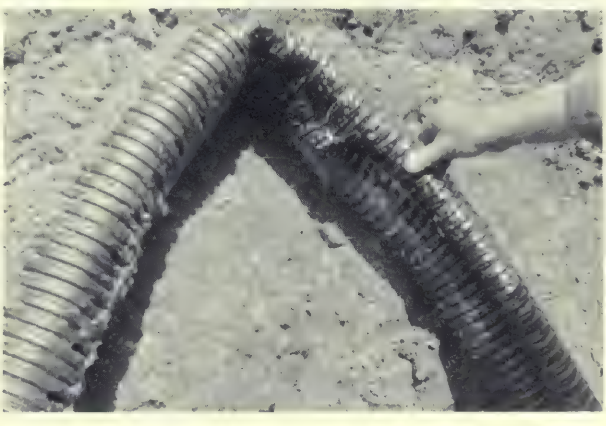
Plautus said in about 200 B.C., "It's a miserable usiness, waiting till thirst has you by the throat before you dig a well." The same thought holds true today. We cannot afford to wait until our lands become seeped before we take steps to reduce our costs—we must act now.

To meet the challenge to reduce the cost of our subsurface drainage work, the Bureau initiated an investigation of new materials and equipment for drain construction. This investigation was carried out in two phases.

Phase I

Phase I of our investigation consisted of installing and evaluating test reaches of corrugated, perforated, polyethylene drainage tubing. We knew

Figure 2. Collapsed drain tubing probably caused by increased pressure by sand concentrated in center of tubing.



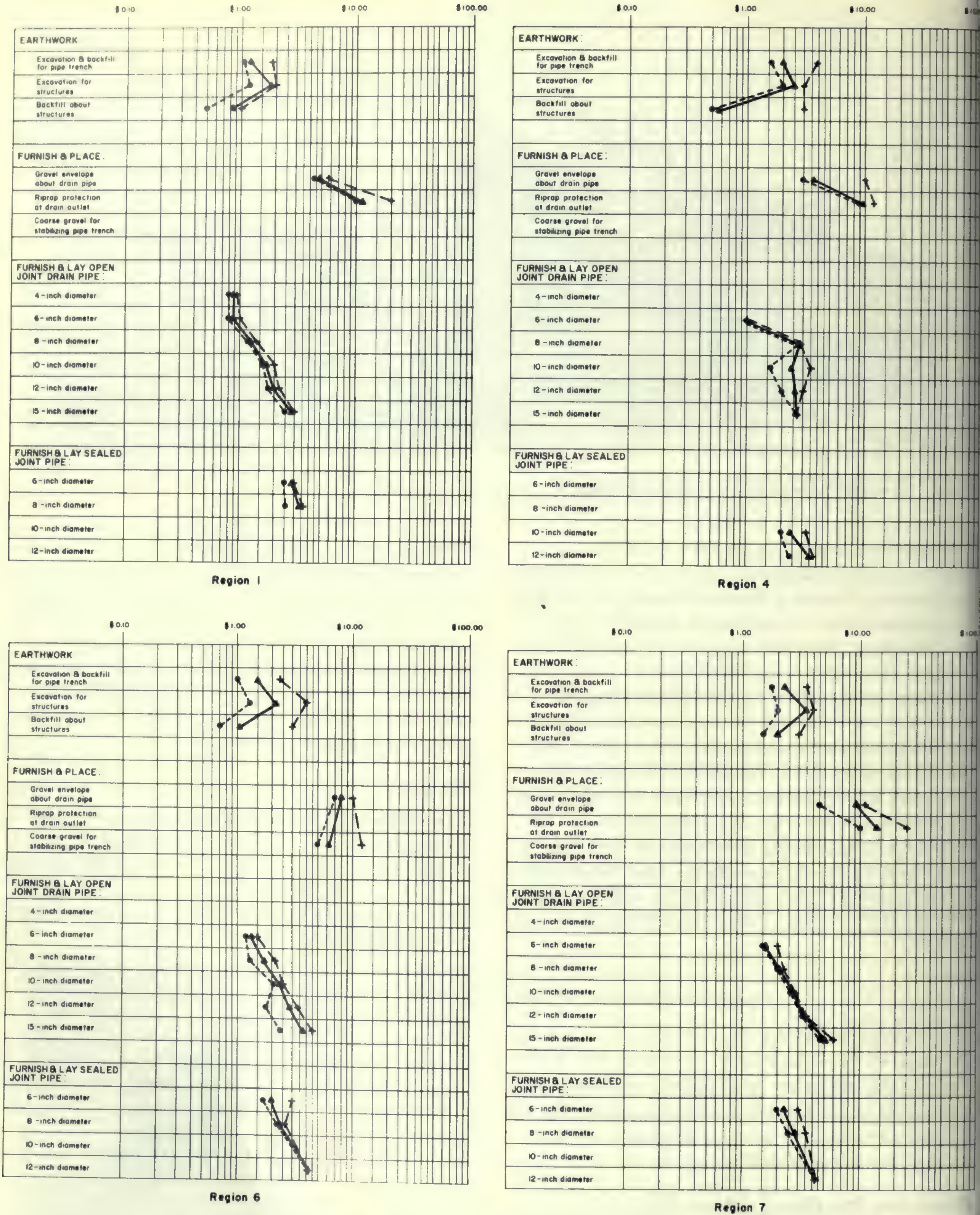


Figure 3. High, low, and average unit costs for drain construction on Bureau of Reclamation projects.

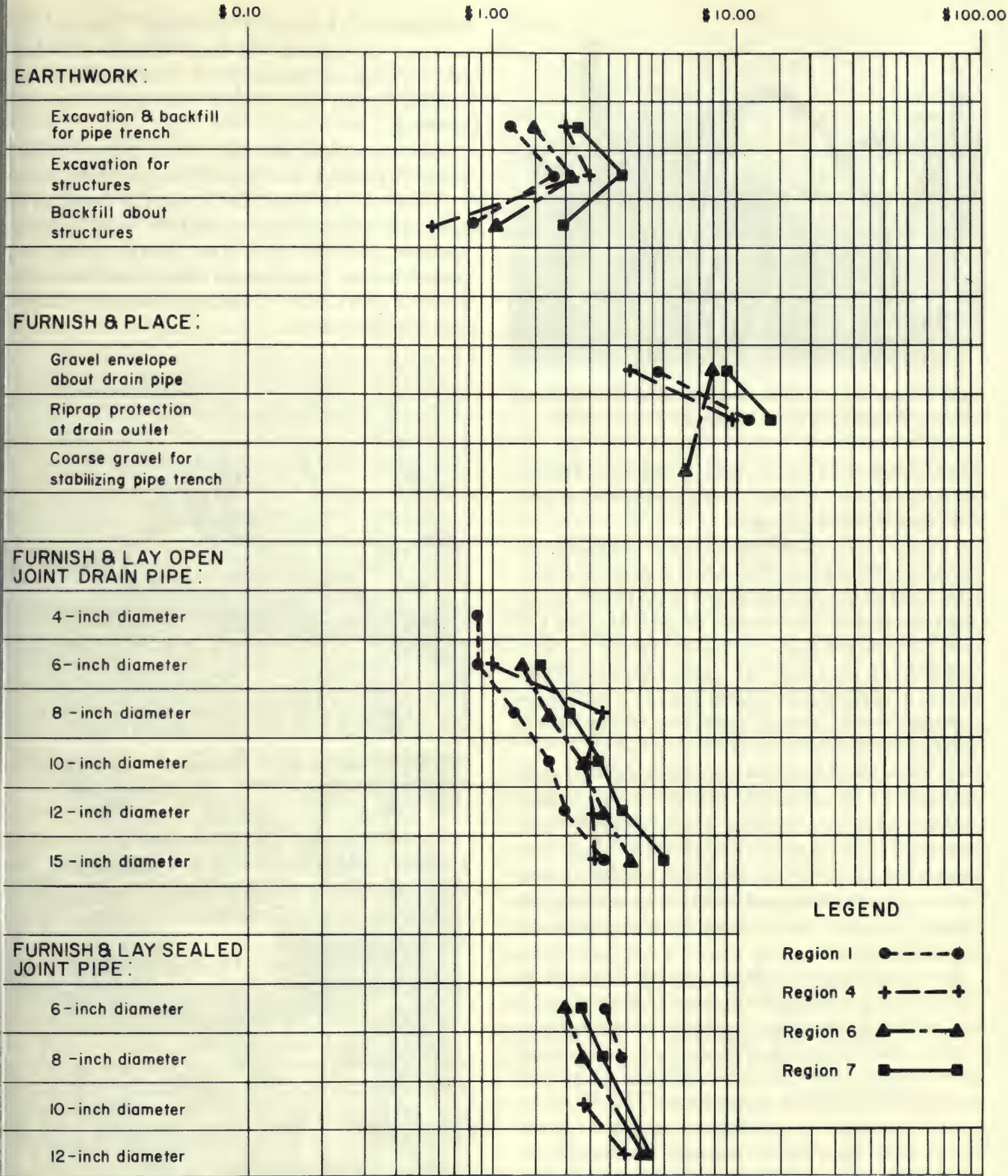


Figure 4. Comparison by Regions of average unit costs for drain construction on Reclamation projects.

Figure 5. Hose "Gigant" trencher and pipe-laying machine placing drainage tubing through gravel hopper and shield in trench.

the polyethylene drainage tubing had some distinct advantages over concrete or clay pipe and it also had some disadvantages.

The advantages are that it is easy to handle and it comes in long lengths which eliminates the danger of pulled joints that allow gravel and dirt to clog the drain and thus cause failure. I might add here that, in the many miles of drains we have constructed, we have had three temporary failures—all due to pulled joints. The third advantage of plastic tubing is that it takes less manpower to install.

On the other side of the coin, there are still some questions to be answered. The foremost question is—how long will it last? Manufacturing companies tell us it is guaranteed for 100 years. Our accelerated laboratory time tests concluded thus far on polyethylene made from virgin materials suggest it may last at least 70 years with no deterioration.

You are probably asking yourselves—what in the world are they worried about? Our answer to this is like banks who deal with other people's money—we just can't gamble as there is no money for replacing drains. Another question we have to answer before making polyethylene tubing an acceptable alternate is whether or not this type of drain can be successfully cleaned. We believe this problem can be solved by use of a water jet cleaner which utilizes water under high pressure to clean out pipe. Future studies will be conducted to either prove or disprove this belief.

Our first installation of plastic drain tubing was in central Nebraska. The tubing was manufactured by Advanced Drainage Systems, Inc., of Iowa City, Iowa. We chose this brand because of its design and because it is manufactured from virgin resins; i.e., resins that have not been recycled.

The tubing was installed with a Garwood Buckeye 4–11 trencher and pipe-laying machine, shown in Figure 1. On our first attempt, the machine was used in the same manner as if we were installing concrete and clay pipe. The plastic tubing, supported on two 1-inch longitudinal steel bars about 4 inches apart, was fed through the gravel hopper and into the trench.

Figure 6. "Gigant" machine manufactured by Klaus-Gerd Hose, Oldenburg, Germany.

To provide good circumferential support to the plastic tubing and protect it from uneven pressures that might be caused from caving of the trench, the gravel envelope was increased from 4 to 6 inches.

After about 50 feet of tubing had been laid, it was discovered that the tubing had collapsed. The tubing took the form of a lazy B with the flat portion on the top, as shown in Figure 2. It is our theory that the two guide bars that normally guide the concrete or tile pipe were making voids in the sand as they traveled along the trench and the uplift pressure from the approximate 10-foot column of sand was being concentrated in the center of the tubing, thus causing the failure.

The contractor modified his machine by running the tubing through a piece of tile pipe in the hopper to protect it. This eliminated the concentration of pressure on the tubing and 700 linear feet were successfully installed approximately

hree times faster than it took to install an equiva-ent length of concrete or clay pipe.

A second test reach consisting of 1,300 linear eet of tubing was installed south of Superior, Nebr., by the same contractor using the same quipment. This area was selected because the rain was to be constructed in a very unstable andy silt. Total construction rate to install the lastic tubing averaged just under 4 feet per min-te. While this rate was not exceptionally fast, it s about twice the rate an adjacent reach of clay le drain pipe was installed.

Phase I of our quest to reduce costs of drainage ork proved that plastic tubing could be installed ith conventional equipment at about two to three mes the speed of installing concrete or clay tile rain pipe.

However, care had to be exercised in installing lastic tubing because it can be easily damaged. urther, in our discussions with the contractor, e believed he could reduce our contract costs about 1.00 per linear foot. This reduction was verified y bids wherein the specifications allowed con-ractors to bid on a plastic tubing alternate for 4,000 feet of 6-inch drain pipe.

gure 7. Typical connection between two sections of plastic drain.

Phase II

Phase I of our investigations proved we were on the right track in reducing our drainage costs, but it was only an appetizer. Although some saving was realized, we didn't feel that any appreciable saving could be obtained until the state of the art in laying plastic tubing had been considerably advanced. The saving we obtained thus far has been in the cost of the pipe and reduced labor requirements.

Conventional equipment used by contractors in our area is either a trencher such as the Garwood-Buckeye 4–11 which excavates a minimum trench width of 24 inches, or a dragline with a slip shield. In this operation a man is required in the bottom of the trench, within the shield to help place the rigid pipe. Either method excavates excess widths, especially for the smaller pipe in the 6- through 10-inch sizes, resulting not only in excess excavation but excess gravel envelope which alone has been costing $1.00 per linear foot.

With this in mind, Phase II of our research project was to find new equipment capable of laying plastic tubing at high speeds and at accurate grades. Through this search, we discovered a German-made, high-speed trenching machine designed especially for laying plastic drain tubing.

This machine is a Hoes "Gigant" trencher manufactured by Klaus-Gerd Hoes of Oldensburg, Germany, shown in Figures 5 and 6. A Bureau inspection team traveled to Arthur, Ill., to witness the performance of this trenching and pipe-laying machine. This demonstration consisted of laying approximately 1,500 feet of 5-inch plastic drain tubing at depths between 3 and 6 feet in clay soils. The machine, using a chain- and bucket-type excavator, can dig a trench as narrow as 10 inches and as wide as 18 inches and to depths of 8½ feet. The approximate rate of trench excavation and placement of 5-inch plastic drain tubing in a 10-inch trench was observed as follows:

Trench depth (ft.)	*Rate of excavation (ft./min.)*
2	50
3	40
5	30
6	25

These rates, when compared to conventional-type trenchers, which will lay plastic tubing at depths of 6½ and 7½ feet at a rate of 4 to 6 feet per minute, are rather fantastic.

The depth and slope of the pipe or grade were controlled by a laser beam system, which is a necessity for any high-speed trencher. After the tubing was laid, the grade was checked and it was never more than 0.02 foot off grade.

Backfilling of the pipe can be accomplished by a horizontal screw conveyor, dragging a "V"-shaped blade or by use of a bulldozer.

From the performance observed at Arthur, Ill., we believed this type of trencher had the potential to reduce drainage costs. Arrangements were made to hold a "field day" at Courtland, Kans.

The object of this "field day" was three-fold: (1) to demonstrate the capabilities of this type of trenching and pipe-laying machine; (2) to stimulate interest in ways to obtain better and more economical methods of constructing subsurface drains; and (3) to motivate more contractors to become interested in drainage construction.

Two stubs of a subsurface drain ½ mile north of Courtland, Kans., were installed during the demonstration. The lengths of the stub lines were 800 feet and 1,200 feet, with depths ranging from 6.5 to 7.5 feet. Soil in this area varied from a silty clay loam to a heavy clay loam. The water table was approximately 3.5 feet below the ground surface. The rate the trencher installed the tubing at the 7.5-foot depth with a gravel envelope averaged 15 feet per minute. The trencher's performance at other depths was comparable with the results demonstrated in Illinois.

This demonstration confirmed our belief that a high-speed, chain-type trencher has good possibilities in reducing drainage costs in areas where soils are relatively free from rocks and other hard materials. However, Vermeer Manufacturing Co., Pella, Iowa, has introduced a similar type trencher which utilizes very rapid moving, chisel-type cutting teeth suitable for almost all types of soils.

During this "field day" we had an opportunity to discuss our construction requirements with several small contractors. We found these contractors were interested in bidding on our work, but were scared away when they saw the depths required for our drains.

Earlier I mentioned the depths we strive at varied from 9 to 10 feet. These depths may seem deep; however, they were not arrived at haphazardly but are the result of economic studies evaluating equipment presently on the market versus the horizontal drain spacing required to drain a field.

A similar analysis was made from results obtained during the field demonstration and from prices quoted for constructing Soil Conservation Service approved drains in Illinois and Iowa. This study concluded the optimum depth for drains constructed by equipment such as that used in the demonstration was about 6 feet. At this depth, drains could be constructed for about $4,800 per mile. We must keep in mind, however, that at this 6-foot depth, approximately 2 miles of drain would be required to drain adequately the same area or to replace 1 mile of drain at the deeper level. This would make an equivalent cost of $9,600 per mile, exclusive of manholes. When you compare this to the $32,000 per mile drains are now costing, the results look promising.

Where Do We Go From Here?

We have initiated a cost reduction program which has proven the cost of our subsurface drains can be reduced by $5,000 per mile. This is only a beginning. We are optimistic this saving can be doubled or even tripled. How can this be done?

We have created token interest from such equipment manufacturers as Caterpillar Tractor Co. and Vermeer Manufacturing Company. We will continue to work with manufacturers, urging that they explore the market potential for equipment that will install plastic drainage tubing faster, deeper, and at less construction cost than equipment presently on the market.

There is a possibility of developing a technique for Bureau use which would only involve simultaneously slicing through the earth and playing out the tubing at the bottom of the cut. In this case, no gravel envelope would be required.

We feel the time is ripe to cultivate this interest. Who knows—maybe equipment designed for drainage work can also be used to plow in high voltage transmission lines or low head irrigation supply systems. We will question contractors who expressed an interest in our work but did not submit bids. Maybe we can take their reasons for not bidding into consideration on our next job.

We will question contractors who are presently constructing our drains on how they believe we can reduce the costs from a construction standpoint.

And last but not least, we will continue to question ourselves. # # #

Crisis Simulation Training

"AN ounce of prevention is worth a pound of cure" could be the motto of the ower Operator Training Center located at the .S. Bureau of Reclamation's Engineering and esearch Center in Denver, Colo.

A training center that can simulate exact oper- ting conditions at hydroelectric power generating nd transmission facilities has been completed and in full operation. Shortly after the Northeastern lackout of 1965, when a massive electric power ilure paralyzed most of New England and parts f the Eastern Seaboard and Canada, the Bureau ok steps to prevent such an occurrence in the Vestern States where its hydroelectric generating nd transmission facilities are located.

Completed in May of this year, the center pro- ides refresher and advanced training for the Bu- eau's more than 300 power operations personnel. uring the 2 week training periods, power opera- ions personnel are trained in taking proper and mmediate corrective steps to restore service to a ystem during an emergency.

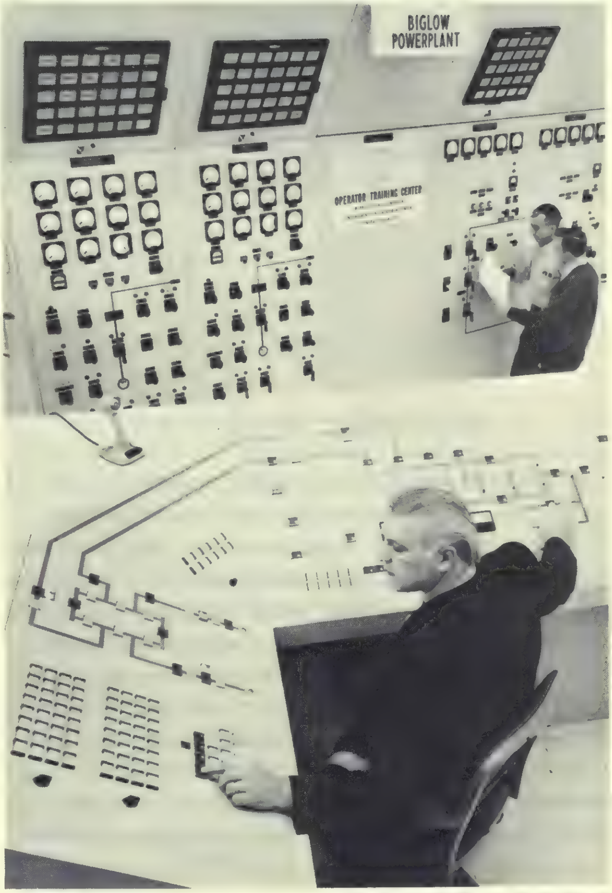
Failures, interruptions, and outages can be imulated without forewarning by instructors in uch the same fashion that actual emergencies evelop on real power systems.

"The nation's electric power generation and ransmission networks have become so sophisti- ated and interdependent," said Commissioner of eclamation Ellis L. Armstrong, "that the human lement is more critical than ever in dealing with mergencies. Our goal is to assure that the tech- icians responsible for the proper operation of hese systems are the most able, best qualified, most ighly trained specialists anywhere."

The trainees are Bureau of Reclamation power perators with a minimum of 3 to 5 years of experi- nce. Many, however, have never been exposed to ll types of operating emergencies.

Their training room at the Operator Training Center is a full-size control room completely quipped with realistic switchboard panels, con- rols, and relays of the latest type. More than 25 niles of wire and cable were used in establishing he training facility.

The powerplant is simulated to represent a plant with two hydroelectric units, each with a capacity f 200 megawatts. All necessary current and po-



Seated like the commander of a space ship, Roy Scott, construction engineer for the Training Center, prepares to create a fault that will be identified and corrected by power operators.

tential transformers, circuit breakers, and fault applicators, as well as reactors, capacitors, and resistors are provided.

The entire facility is commanded from a con- trol console by which the instructor can simulate any desired fault condition and adjust system loads. A timer system is built into the control con- sole so that any action may be programmed by the instructor, thus introducing the element of surprise.

Since the Bureau of Reclamation's extensive power system consists of 50 powerplants, 300 sub- stations, and more than 16,000 miles of transmis- sion lines, a training center of this scope was greatly needed. The $400,000 center is designed to be the ounce of prevention necessary for the con- tinuing operation of Reclamation projects.

# # #

FIFTY YEARS AGO
in Our Magazine

RECLAMATION RECORD 1921

FOREIGN VISITORS

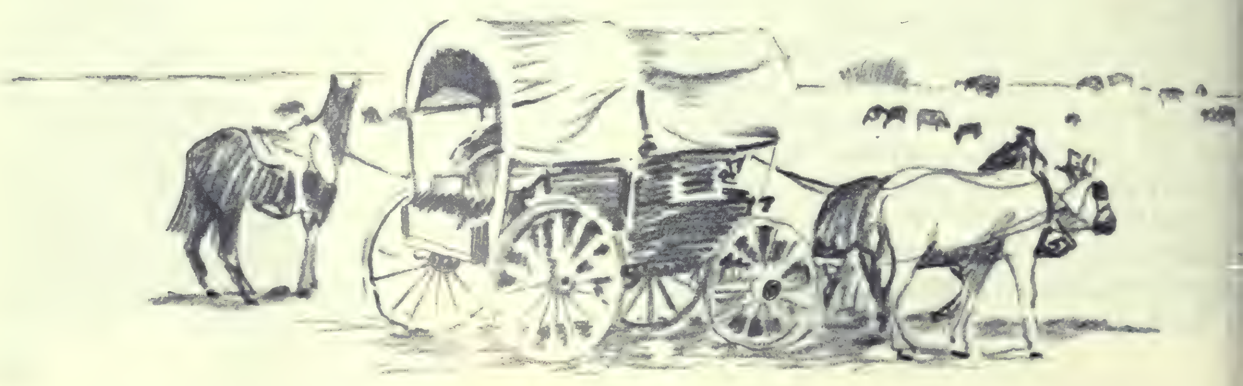
ALMOST from the beginning, the work of the Reclamation Service has attracted the attention of foreign engineers and officials interested in irrigation and flood control. This is no doubt, due in large part to the publicity given the work by the technical press and by such publications as the National Geographic Magazine.

Previous to the World War a large number of officials from foreign countries visited the Washington office of the service and many of the Government irrigation projects in the West, and the eleventh annual report contains reference to these visitors as follows:

> Nearly every foreign country having large areas of arid lands has been represented by visitors who have studied the works on the ground, and particularly the methods and analyses of cost. Official and unofficial representatives from Great Britain and its colonial possessions, notably from South Africa and from Australia, have visited the works; also engineers and agricultural experts from various portions of the German Empire, from Austria, Russia, Spain, and other European countries, and from Mexico and South America. These men have been interested not only in irrigation but in the control and conservation of flood waters.

SIERRA ANCHA DEVELOPMENT

IN creating Roosevelt Lake by the building o the great Roosevelt Dam to furnish irriga tion water for the Salt River project, Arizona, th Reclamation Service brought into being man incidental attractions of great popular appeal, bu the ferry over the east arm of the lake was not on of them. The ford used to cross the Salt River o the road from Globe up into the Sierra Anch country was gradually encroached upon by th reservoir until the silt deposits from the alter nately rising and receding water compelled th abandonment of the ford and the establishment o a ferry. The structure installed was not a particu larly seaworthy craft, nor were the natives of thi region a seafaring people. Although a great nov elty in this part of the country, the style of trans portation did not develop popularity. Rough wate on the lake meant canceled trips, and no amoun of protest could convince the ferry captain tha sailors should not confine their labors to eigh hours like other people.



today...

Interest in Reclamation activities during the past 50 years since 1921 has greatly expanded. Over 110 nations have sought and obtained technical assistance in the broad field of multiple-purpose water resource development. This assistance has involved 3 broad categories: (1) training foreign nationals in our own facilities; (2) providing consultation on various aspects of water resource development abroad; and (3) water resource planning abroad, accomplished with counterparts from the host nations. All of this effort has the goal of improving man's living conditions.

It is interesting to note that, while the techniques used in planning, design, construction, and O&M have been improved and expanded since 1921, basically, the same Reclamation activities are of interest today as 50 years ago. For example, economists are still intrigued with the success of our reimbursement policy; i.e., that many water user organizations have successfully paid back the Federal investment and are now operating their own projects.

Although detailed records on trainees, observers, and visitors are sketchy prior to 1950, since that date we have worked with about 1,700 trainees, 2,000 observers, and over 4,000 visitors for a total of about 7,700 technicians from 110 countries.

Completion of the ferry route road, now State Highway 288 through Young and on to Heber, provided access to the rim country for ranchers, Forest Service crews, some tourists, etc. However, the more popular and better improved routes for tourists and recreation seekers to the Mogollon Rim country are U.S. Highway 60 (Phoenix-Globe-Showlow) and State Highway 87 (Phoenix-Payson-Winslow).

While the industrial, recreation, and farm development aspects visualized to take place from development of the ferry road did not materialize, Theodore Roosevelt Lake, together with those lakes built in the 1920's by the Salt River project below Roosevelt Dam for power development, created tremendous recreation opportunities for thousands of visitors each year from the Phoenix-Globe areas, as well as tourists from out of State. These lakes: Saguaro, formed by Stewart Mountain Dam; Canyon, formed by Mormon Flat Dam; Apache, formed by Horse Mesa Dam; and Theodore Roosevelt Lake, provide an almost continuous body of water, having a total surface area of 22,170 acres available for recreation use within a few miles of the Phoenix metropolitan area. Visitor-day use in calendar year 1970 amounted to 1,274,000 for the combined lakes.

HOMESTEADE

by **HAROLD E. ALDRICH, Regional Director
Region 6—Billings, Mont.**

SEEKING a needle in a haystack was just as futile as most of us would suspect, but to the youngsters who attended the "Homesteader Days" celebration in Billings, Mont., it became a new sport. The "Homesteader Days," sponsored by the Huntley Project Lions Club, drew nearly 800 citizens of the Huntley area for a Saturday and Sunday of fun, prizes, and competition which ranged from butter churning to flower arranging to livestock growing.

Why the celebration? Homesteaders in this part of Montana were celebrating the settlement of Huntley, one of the pioneer Reclamation projects of the West. First authorized on April 18, 1905, this development is located in an area of considerable historical significance and also of pleasant surroundings.

The project is situated in southcentral Montana on the south side of the Yellowstone River between Huntley and Custer. This area was at one time the scene of considerable Indian activity and the main military routes traveled by the U.S. Cavalry.

In fact, the project locale must have always been an appealing place. As far back as 165 years ago, explorer William Clark spent quite some time in the area. Captain Clark even scratched his name on a rock—Pompeys Pillar—now a famous landmark, and also compiled considerable notes concerning the area in his now-famous journal.

The Huntley area has proven to be attractive to many people. Even before a single tent was pitched in the "magic city" of Billings, Montana, it was a busy spot. Early history records the operation of a ferry across the Yellowstone, which was the start of a communication link between military posts. A popular hotel with eating and

AYS CELEBRATED

drinking accommodations, a fur-trading post, and a warehouse and steamboat operation also helped create a lively scene for the Huntley area in the 1870's.

Even though Huntley was a beehive of activity during the wide use of the steamboat, this action was eventually doomed by the coming of the railroad which made Billings its main stop. However, oblivion was shortlived—with the advent of the Huntley Irrigation project new life was breathed into the area.

About 64 years ago—on June 22, 1907—drawings for homesteads on the Huntley project were started. On that day the hardy homesteaders started to push and shove gophers and rattlesnakes off sagebrush-covered, ant-infested, practically nonproductive land. Through the hard work of these pioneers and those who followed, this area has been turned into a checkerboard of fertile fields producing millions of dollars of farm produce annually. This sustained production has contributed to the growth and stability of the area, the state, and the nation.

Today the area is dotted with farms, homes, trees, flowers, shrubs, and gardens. The generative nature of irrigated farming has been an important factor in the establishment of a stable and healthy farm life that has endured down through the years. What has been accomplished has taken place in an area that was once largely unproductive, and certainly represented a major challenge to the hardy homesteaders of yesterday.

Project lands were originally ceded Indian lands. There was a time when its value was something less than a nickel an acre. The Indians received $4 an acre for this land—today its value is in the neighborhood of $450 to $600 an acre. However, dollars per acre are hardly the measure

Struggling with a half-plucked chicken was only one of the old-time events revitalized during "Homesteader Days".

of true value or real worth of an irrigation development.

Agriculture is big business in Montana, and irrigated agriculture is a really big stabilizing factor in the farm picture. In Montana the irrigated agriculture on Bureau developments alone totals more than one-third million acres, producing crops with a value of $22 million annually. There are 2,500 families on farms on Reclamation developments in the state. About 10,000 people are supported directly from this enterprise, and another 17,000 to 18,000 indirectly. This obviously provides a very stable assist to Montana's agricultural economy.

Since authorization of the Huntly project, about 80 percent of the $2.8 million appropriated for construction has been repaid to the Federal Treasury.

The project does more than pay its way—its 24,000 acres of irrigated land support nearly 200 families. There are about 800 members of these families circulating in the surrounding communities, spending and generating activity from irrigated agricultural income.

The Huntley project has been a productive factor and had a stabilizing influence on area community development. It has certainly been a healthy complement to the Yellowstone Valley, particularly in the Billings area, and has helped immensely to create an economically stable region.

This, of course, is a natural long-term benefit that comes from Reclamation developments. It is a typical picture throughout the western United States where Reclamation developments are located. You can find example upon example of well-balanced family life and community stability. These benefits are derived through irrigated agriculture.

Community efforts to recognize the value of the project and to honor the homesteaders who settled the project culminated in the "Homesteader Days" celebration held July 17 and 18 of this year.

Contrasting with those engaged in fun and games was a much smaller group which was more interested in the advancements made through research. This group surveyed many potential new crops; compared haying and forage systems; they investigated new fertilization results, pest control trials, and landscaping.

With such variety in the activities during "Homesteader Days" it is no wonder that there was something to please and interest everyone who attended. # # #

Looking for a needle can be great fun, especially if you're ten and attending the Huntley Project's celebration.

MILE-HIGH ROSES

by **DEAN SCHACHTERLE, Chief of Land Management and Recreation Region 7, Denver, Colo.**

WHITE glistening peaks of the Rocky Mountains form the setting where a young horticulturist cultivates mile-high roses.

James A. Fizzell from Illinois manages a complex of greenhouses near Lafayette, Colo., where roses are grown the year round for retail marketing in the southeastern part of the United States. Fizzell came West after earning two horticultural degrees, B.S. and M.S., at the University of Illinois. After serving as County Agricultural Agent in the suburbs of Chicago, he sought a new challenge by growing roses throughout the four seasons in a mountain climate one mile (5,280 ft.) above mean sea level.

Fizzell very ably manages the 125,000 square feet of space under greenhouse cover for Colorado Roses, Inc., a subsidiary of Davis Brothers Florists, Inc., Denver, Colo.

Among the necessary environmental ingredients needed to grow roses, water is by far mosts important to assist not only in the growth of rose plants but also to control the climatic conditions, temperature, and humidity on the 2.8 acres of Colorado-Big Thompson project lands covered by 10 greenhouses.

Part of the water required for this operation is delivered through the Left Hand Ditch from Colorado-Big Thompson project. Additional water is pumped from wells located on the property.

There is nothing new about growing roses is a greenhouse, except that here it is done in a mountain environment. Wide fluctuations between daytime and night temperatures, low relative humidity, and a difference in the composition of mile-high air necessitated a special design for the greenhouses and a mode of operation not experienced in the older rose-growing sections of the eastern United States.

Growing Market

Since ground was first broken in January 1969 for construction of a business unique to the Rocky Mountain area, the market for cut roses has steadily increased.

The present operation includes 89,000 plants which yield an average of 25 flowers per plant each year. The 2,225,000 roses produced annually grace many households and businesses. They most certainly lighten the moods and hearts of the many ladies who receive these beautiful flowers as a token of love and friendship from their cherished mate.

Fizzell indicated Colorado Roses, Inc., has plans on the drawing board to expand its rose-growing operation four-fold, as the market increases and economic conditions improve.

Selection, cutting, grading and wrapping roses are necessary steps for quality bouquets and floral arrangements.

The vast greenhouses of Colorado Roses, Inc. are framed by the vital water tanks and well pump which transports Reclamation water to the flowers.

ulture

The thousands of rose plants now growing in scientifically controlled environment are obained from an Oregon grower when they are months old.

After planting in the greenhouse, they are in full roduction in 6 to 8 weeks and continue to proluce high-quality flowers for 5 years. Although nany plants will live up to 15 years, they are all eplaced at the end of 5 years because of the harp drop in production and poor quality of owers.

Climatic conditions for growing high-quality oses are critical and must be carefully controlled n the greenhouses to simulate a semi-tropical clinate. The night temperature must be held at 65°F. nd the daytime temperature between 75° and 0°F. with a relative humidity of 75 to 80 perent. These climatic factors can be more careully controlled in winter months than during the ummer; therefore, the production and quality f roses is the highest during the winter season.

Roses are grown in beds on the floor of the reenhouses with sufficient space between beds to llow harvesting and caring for the plants. The lants are fertilized according to need which is letermined by regular soil testing and plant tissue esting by the nearby Colorado State University aboratories.

Disease and Insects

Disease left uncheck in an operation of this magnitude can be disastrous. Mildew, a fungus disease common to roses grown indoors or outdoors in a garden, is by far the hardest disease to control. At present, several fungicides are available to the indoor rose grower that are effective and not toxic to greenhouse workers. Carefully controlled temperatures and humidity are also important factors in prevention of this disease.

Insects pose little or no problem in the greenhouses because of insecticides which are effective control agents and have a low human toxicity.

Production

Fizzell has 12 year-round employees who assist in planting, growing, cutting, grading, and packing roses for market. Because of the heavy work, most greenhouse work is done by men and the grading and packing by women.

James A. Fizzell, Plant Manager, operates a mechanical grader which grades up to 3,600 roses an hour, utilizing a series of light beams and photo electric cells.

Seventeen varieties of pink, red, white, yellow and orange roses are grown and marketed. Of these five colors, red is by far the most popular and there appears to be no consumer preference in regard to a scented rose versus a nonscented one.

As soon as the roses are cut each morning, they are placed in a cooler until the women workers can grade and pack them. After grading and packing, they are returned to the cooler until the following morning when they are trucked to the distribution center, Davis Brothers Florists in Denver.

Colorado Roses, Inc., has certainly proved that the Rockies' mile-high environment is excellent for growing roses under cover and that many people still prefer a live rose to an artificial one.

# # #

NEWS NOTES

Secretary Morton Completes "Operation West"

Secretary of the Interior Rogers C. B. Morton spent most of August in four 1-week get-acquainted and fact-finding visits to the Southwest, Pacific Southwest, Pacific Northwest, and the Missouri Basin Region.

While in the Southwest, Morton was accompanied by Assistant Secretary for Public Land Management Harrison Loesch; in the Pacific Southwest by Assistant Secretary for Water and Power Resources James R. Smith; in the Pacific Northwest by Assistant Secretary for Fish, Wildlife and Parks Nathaniel P. Reed and in the Missouri Basin Region by Assistant Secretary for Mineral Resources Hollis M. Dole.

Secretary Morton toured Lake Powell, visited an Indian training school, a sacred Indian retreat which was recently restored to tribal ownership, and a national park, to name only a few stops.

Morton commented upon the trip, "During the past month, I met the people whose views will help shape the course of the western United States and examined those lands and resources to whose trusteeship and wise use we in the Department of the Interior are committed."

U.S.-Spain Cooperative Study of Water Problems Proposed

A memorandum proposing that the U.S. and Spain jointly explore areas of technical problems in water resources development was signed in Madrid by Commissioner Armstrong and Dr. Ing M. Gomez De Pablos, Director General of Hydraulic Works (Direccion General de Obras Hydraulics—DGOH). Commissioner Armstrong said the joint exploration of areas of technical problems confronting the Bureau and the DGOH should be of significant value to both nations as the exchange of information and advancement of technology progresses.

Topics on which joint studies "would be especially rewarding" were listed as: dam engineering geology; the effects of storage upon the quality of water and environment; abrasion resistant concrete; underwater and submarine aqueducts; hydro-bionomy; hydro-power contributions to the electrical stability of major transmission systems; and exchange of publications and translations.

The joint program of cooperation to be prepared would include: exchange of personnel and other activities related to each of the projects; estimates of time and monies involved; and goals to be achieved.

Highest Cloud-Seeding Research Station

The Nation's highest cloud-seeking research station, 12,800 feet above sea level in the Colorado Rockies, will be constructed shortly as part of the Bureau of Reclamation's "Project Skywater," Secretary of the Interior Rogers C. B. Morton announced in Denver.

Commissioner Ellis L. Armstrong said the facility will be located near Red Mountain Pass, between Ouray and Silverton, Colo., and will be emplaced and serviced entirely by helicopter. He said the station will house instruments and recording devices to monitor wind velocity, temperature, snowfall, rime ice accumulation, and solar radiation. It will not be manned, but will transmit its data by radio to Durango, Colo., headquarters for the Bureau's Colorado River Basin Pilot project.

The research station will be installed by Western Scientific Services Inc., of Fort Collins, Colo. under a $39,470 addition to an existing contract. This contract was for the installation and operation of a network of instruments situated throughout the operations area for the pilot project.

The 6 x 8 foot metal structure will be located on Mule Shoe Mountain, one mile from U.S. Highway 550. Electrical current to heat the vital instruments will be provided by propane-fueled generators.

Data from the station will be of interest principally to project scientists in their analyses of how atmospheric conditions relate to avalanches frequently occurring in the area. Four known slide areas are located near the facilities.

Two Medicine Dam Transferred to BIA

Operation and maintenance of Two Medicine Dam in Montana has been formally transferred from the Bureau of Reclamation to the Bureau of Indian Affairs.

Commissioner of Reclamation Ellis L. Armstrong said the dam, designed and constructed under emergency conditions by the Bureau of Reclamation, replaces a BIA structure destroyed by floods in 1964. Water from the project aids ranch-

ng and farming operations on the Blackfeet Reservation.

Completed in 1967, the dam is located on Two Medicine Creek on the reservation about four miles northwest of the village of East Glacier Park, Mont. It underwent a period of testing before being turned over to BIA operation.

Commissioner of Indian Affairs Louis R. Bruce commended the Bureau of Reclamation's participation which has enabled continued operation of the dam for the Two Medicine Unit of the Blackfeet Irrigation project. "The cooperative effort between the two bureaus," stated Bruce, "is a favorable reflection on the Department."

Look to Clouds for Added Water Source Within 20 Years

In a paper presented at the Eighth World Energy Conference held in Bucharest, Romania, in June 1971, James R. Smith, Assistant Secretary for Water and Power Resources, noted the Bureau of Reclamation is undertaking a major program to develop cloud seeding techniques for precipitation management.

In mountainous regions of Montana and Colorado, where snowpack accumulation is a primary water supply source, seeding of winter storms has resulted in increases in average season precipitation of between 10 and 20 percent and increases of 100 percent or more from some clouds or storms, Smith added.

Smith told participants in the international energy conference that an estimated 47 billion acre-feet of water vapor in the atmosphere blows across the United States each year. Of this amount, only about 10 percent—or 4.7 billion acre-feet—falls in the form of precipitation.

Smith said cloud-seeding operations in the high mountain ranges of the Upper Colorado River Basin in Colorado have been "most successful." He pointed out that natural water supplies in this river basin are among the most critically short in the United States. "This project, which is programmed for 9 years from 1968 through 1976, is thus far the largest and mosts comprehensive seeding research program conducted by the Bureau of Reclamation," Smith said. "An important part of this pilot project will be an extensive ecological study to determine what effects additional snowfall has on mountain ecology and environment."

He said technology developed through the cloud-seeding projects indicates that precipitation management through such experiments is rapidly becoming a useful reality.

Environmental Advisory Panel Appointed

A panel of ecologists to advise the Bureau of Reclamation on environmental problems has been established.

Commissioner of Reclamation Ellis L. Armstrong said *Dr. W. Frank Blair*, University of Texas zoologist and ecologist and current vice president of the American Institute of Biological Sciences, will serve as chairman of the advisory group.

Elwood A. Seaman, Assistant to the Commissioner—Ecology, will act as co-chairman and secretary to the panel.

Other members appointed to the group include:
Dr. Thomas Edmondson, University of Washington, Seattle, limnologist and pollution specialist.
Dr. Stanley Auerbach, radiation ecologist, Oak Ridge National Laboratory, Tenn., specialist in health physics and water chemistry.
Dr. George Sprugel, Director, Illinois Natural History Survey; administrator-scientist, general environmentalist; former Chief Scientist, National Park Service.
George Eicher, power biologist, Portland General Electric Co., Oregon; consulting industrial biologist, authority on problems of hydroelectric powerplants in relation to stream biology.
Dr. William J. Hargis, Director, Virginia Institute of Marine Science and Dean, School of Marine Science, College of William and Mary; marine scientist, authority on marine chemistry, particularly salinity.

Commissioner Armstrong said establishment of the panel would meet the need for "independent, objective analysis by non-Bureau experts who can supply fresh, new or special viewpoints" in solving particular environmental problems.

He said the ecologists named "come from a wide geographical area and are representative of government, universities and industry." The group includes specialists in water salinity, water chemistry and pesticide-herbicide problems in water courses.

The Commissioner said the group would be consulted to find solutions to specific problems and would probably be called upon to view problems at field locations in order to help arrive at courses of action. # # #

U.S. GOVERNMENT PRINTING OFFICE : 1971 O - 442-270

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has carried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form may be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

FOR USE OF SUPT. DOCS.	

Enclosed find $______________ (check, money order, or Documents coupons). Please enter my subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents per single copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code______________________________

Major Construction and Materials for which bids will be requested through November 1971*

Project	Description of work or material
al Utah, h.	One 24-in., hollow-jet valve and control, Soldier Creek Dam. Estimated weight: 4,000 lb.
ado River age, Colo.	Constructing a 12-ft-diameter, concrete-lined, horseshoe-shaped diversion tunnel, 976 ft long, with a minimum lining thickness of 9 in. to the "A" line; and four 5-ft-wide by 8-ft-high, unlined, modified horseshoe-shaped foundation tunnels having a total length of 730 ft. All tunneling will be through metaquartzite rock. Structural-steel supports will be required for certain reaches of the tunnels while other reaches will be supported by rock bolts in conjunction with or without chain link fabric. An existing road provides access to the bottom of the canyon, but not to the worksite. Crystal Dam on the Gunnison River, about 20 miles east of Montrose.
ado River age, Ariz.	Furnishing and placing bonded thin terrazzo finish on about 35,000 sq ft of rough concrete flooring, and terrazzo flooring and ceramic tile for Visitors Center tunnel. Glen Canyon Powerplant, 2 miles northwest of Page.
nbia Basin, h.	Constructing 6 miles of buried pipe drains and bank stabilization 0.7 mile of open drains on the DE235 and EL31WW systems. Block 42, 7 miles southeast of Moses Lake.
o	Constructing 4.7 miles of buried pipe drains in Block 44, and 1.2 miles of buried pipe drains in Block 49, 10 miles southeast of Moses Lake, and 6 miles southeast of Othello.
o	Constructing additional culverts to increase capacity of DW238WW and DW238WW under State Highway Route No. 283. Principal components of work are: Earthwork for deepening 1,200 lin ft of existing wasteway; installing a corrugated-metal pipe arch culvert and a reinforced concrete pipe culvert; extending reinforced concrete headwalls, and raising height of walls on stilling pool of an existing drop structure. Block 75, 14 miles southwest of Ephrata.
o	Constructing about 2.2 miles of gravel-lined "V" type channel with appurtenant structures for road crossings, to serve as a wasteway for WB38B lateral. Block 25, east of Mattawa.
o	Constructing 12.3 miles of 4- to 18-in.-diameter buried pipe drains. Block 86, 28 miles south of Ephrata.
o	Two 13.8-kv switchgear assemblies and five station service unit substations, Grand Coulee Third Powerplant.
o	Control boards for control of the 500-kv switchyard and Generator Units G19, G20, and G21, Grand Coulee Third Powerplant.
Columbia Basin, Wash.	Two unit control boards for control of generator/motor Units P/G7 and P/G8, Grand Coulee Pumping-Generating Plant.
Emery County, Utah.	Constructing a system of pilot drains, including 1.3 miles of open drains and 1.2 miles of closed pipe drains near Huntington.
Fort Peck, Mont.	One two-channel, single-sideband carrier-current system between Dawson County and Custer Substations.
Navajo Indian Irrigation, N. Mex.	Constructing 2 miles of 1,800-cfs-capacity, concrete-lined main canal with a 23-ft bottom width and side slopes of 1½:1; four monolithic or precast concrete pipe siphons—two 17.5-ft diameter with a total length of 9,600 ft, and two 17-ft diameter with a total length of 6,300 ft; excavating and lining a 17.5-ft-diameter, 500-ft-long tunnel; and constructing a site for the Kutz Pumping Plant about 40 miles southeast of Farmington.
Pick-Sloan Missouri Basin, Wyo.	Earthwork and construction of about 2 miles of pipe drains, Hanover-Bluff Unit.
Pick-Sloan Missouri, Colo.	One automatic recording oscillograph for the Flatiron Power and Pumping Plant.
Teton Basin, Idaho.	Two vertical-shaft, Francis-type hydraulic turbines. Turbine output shall not be less than 13,800 hp when operating at an effective head of 229 ft, speed 450 rpm. A model test will be required. Teton Power and Pumping Plant.
Upper Colorado River Storage, Colo.-Wyo.	Constructing about 38 miles of single-circuit, wood-pole and 5 miles of double-circuit, steel-tower, 3-phase, 230-kv transmission line. Work will consist of furnishing and erecting wood-pole structures; constructing foundations; furnishing and erecting steel towers; furnishing and stringing three 954-Mcm, ACSR 45/7 conductors, and two ⅜-in. steel-strand overhead ground wires on the wood-pole section; furnishing and stringing six 954-Mcm, ACSR 45/7 conductors and two ⅜-in. steel-strand overhead ground wires on the steel-tower section; swinging several spans over to the double-circuit section of line and after energizing the new construction, salvaging 5 miles of 115-kv wood-pole transmission line. Transmission line Archer-Weld 230-kv, Stage 1 extending from Archer Substation, near Cheyenne, Wyoming, to proposed Ault Substation site near Ault, Colorado.

*Subject to change.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibili- for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make full contribution to a better United States—now and in the future.

U.S. Department of the Interior
Bureau of Reclamation

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

February 1972

RECLAMATION era

A WATER REVIEW QUARTERLY

February 1972 • Vol. 58, No. 1

RECLAMATION
era

Kathleen Wood Loveless, Editor

CONTENTS

COVER. Early morning sun and a slight ground fog join to make an eerie and yet beautiful scene on Jackson Lake. See article on page 11.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

A HOPEFUL NEW YEAR

The New Year greeted us with open arms and challenges aplenty. 1972 will be a record year for opportunities and accomplishment.

Congress has supplied funds for the largest dollar program this fiscal year that the Bureau of Reclamation has ever undertaken, and the administration has approved a budget request for an even more active program in fiscal year 1973.

But while these facts are gratifying, our emphasis is not on dollars available but on programs completed, on accomplishments, and on the benefits that will accrue therefrom.

If Congress grants requested funds, we will be undertaking the Oahe project in South Dakota. This project is a companion to the Garrison diversion project in North Dakota. Both will enable the respective States to make greater use of the waters of the Missouri River for the enrichment of the economy in an area where population has dwindled for lack of opportunity.

It will be possible to start active construction on the central Arizona project for which the people of that State have fought and bled for many decades. And work will proceed on many other authorized projects which are equally critical to the areas in which they are located.

The expedited program will permit construction work to proceed at a more orderly and economical rate that will bring immediate job benefits in some areas which are hard hit by unemployment. While these benefits are good, they will be overshadowed by the returns which will accrue from millions of kilowatts of nonpolluting hydroenergy being installed at Grand Coulee Dam, for example, or the millions of gallons of water which will be supplied to cities, industries, and farms throughout the arid West from these projects.

Water is literally life and prosperity in the Western States and the Reclamation program now underway will widen the margin between that prosperity and the disaster which comes when the water supply is exhausted.

Ellis L. Armstrong
Commissioner of Reclamation

London Bridge is up

by EUGENE E. HERTZOG, Chief Photographer
Boulder City, Nev.

FOR millions of Americans who learned the nursery rhyme "London Bridge Is Falling Down" during their childhood, the bridge is a living legend.

It has not "fallen down" but was taken down, stone by stone, and reconstructed at Lake Havasu City, Ariz., crossing a scenic mile-long waterway, now part of Lake Havasu. Forty-five-mile-long Lake Havasu is backed up by the Bureau of Reclamation-built Parker Dam on the lower Colorado River. It is one of several Bureau of Reclamation structures which have brought the Colorado under control and made useful as a servant man.

London Bridge was sold because it could no longer accommodate London's mounting traffic and has been replaced by a new bridge. The bridge was purchased from the Corporation of London in 1968 by the McCulloch Oil Corp. for $2,460,000 in competitive bidding.

Lively Bidding

Bidding was wild and exciting in April of 1968. The story goes that there were at least two bidders willing to pay $2,400,000 for the bridge, but on a hunch, Robert P. McCulloch added another $60,000. When asked why $60,000, he said he figured he'd be 60 years old by the time he had it where he wanted it—on the land bought along the

Famous London Bridge spanning Lake Havasu drew a crowd estimated at 16,000 during the dedication ceremonies at the bridge opening.

Lights on the bridge reflect upon Lake Havasu while gay festivities are in progress under the candy-striped tent.

lower Colorado River for a planned city he believed would eventually have a population of 75,000, hence 60 was a good number.

Whether or not the story is true, the bridge was sold to McCulloch for $2,460,000, who had it dismantled stone by stone and transported 10,000 miles from the River Thames, which it had spanned since 1831, to Lake Havasu City.

The 22,000,000 pounds of stone, each code-numbered, were shipped through the Panama Canal, unloaded at California ports, then trucked several hundred miles across the Mojave Desert.

The world's largest jigsaw puzzle was then reassembled over a period of 23 months. By the labor of only 40 men using modern machinery and methods, this task showed quite an improvement over the same job in the 19th century when it took 800 laborers 8 years to complete.

The Royal Ceremony

The foundation stone of the bridge was ceremoniously placed at Lake Havasu City by Sir Gilbert Inglefield, 685th Lord Mayor of London, on September 23, 1968. And on October 10, 1971, London Bridge was opened to the tune of blowin[g] trumpets by Sir Peter Malden Studd, 688th Lor[d] Mayor of London, and Governor Jack William[s] of Arizona.

The fanfare surrounding the bridge's reopenin[g] rivaled the splendor of the opening festiviti[es] King William IV held to celebrate the bridge['s] London opening on August 1, 1831.

Even though the main course of the openin[g] banquet—lobster and roast beef—was the sam[e] the logistics of serving the meal would have place[d] the King in a quandry. In 1971, the complete din[-]ner and all that went with it—vegetables, sala[d] soup, dessert, wine; bone china, glassware, cut[-]lery; cooks, waitresses, etc.—were trucked 30[0] miles from Los Angeles.

The dinner for 800 held under a candy-stripe[d] tent, was a showroom of 19th century costumes i[n] fantastic colors. Beneath the chandeliers of th[e] tent, Sir Peter Studd, wearing the ancient cere[-]monial clothing and trappings of his office, greete[d] guests who had come to see this large antiqu[e] erected.

Construction of the Bridge

The rebuilt bridge is much stronger than th[e] structure in London, despite weighing only abou[t]

one-quarter as much and taking only about one-fourth the time to build. Provisions for expansion and contraction of as much as 6 inches were made. All piers rest on Rotoflon bearings built into the pier footings.

The steel-reinforced concrete superstructure of the brige was completed in October 1970 by M. M. Sundt Construction Co. of Tucson, Ariz., under a $1.6 million contract with McCulloch Properties, Inc. Affixing of London Bridge's granite stones to the superstructure was completed late in the summer of 1971.

Construction of the mile-long waterway that flows beneath the arches of London Bridge, required removal, through combined excavation and dredging operations, of more than 2,500,000 cubic yards of earth. The waterway is approximately 150 feet wide at each end, 750 feet across at the bridge site and ranges in depth from 10 to 15 feet.

The $1.6 million English Village complex, planned by C. V. Wood, Jr., designer of Disney-

Lord Mayor of London, Sir Peter M. Studd, presents the First Place Family Award in the Elizabethan Dress Contest.

The 19th century English Village created on the riverbank adjacent to the London Bridge is complete with shops, restaurants, and pubs.

land, occupies 3 acres and is the first phase of an international resort complex adjacent to the north end of the bridge on the mainland.

Site Six

Lake Havasu City has come a long way since World War I when it was "Site Six," named and used by the Army as a semi-secret camp to rehabilitate Air Corps pilots suffering from combat fatigue and psychoses.

From Site Six, it developed into a remote fishing camp; so secluded was the camp that only 4-wheel drive vehicles could get there by driving south from Topock. But in the short span of 7 years, Lake Havasu City burgeoned to a population of more than 8,000.

The vigorously growing community has earned recognition as a prototype for new cities of the future, cities that will be needed to meet the demands of America's predicted population growth.

Lake Havasu City has turned a 26-square-mile stretch of barren but beautiful lakefront land into a year-round resort with sandy beaches, green golf courses, boating accommodations, modern hotels, well-kept campgrounds, an airport, and more than 400 businesses and professional enterprises. Now to top it off—it is the new home of historic London Bridge. # # #

WATER Quiz

1. In what two areas of the world did irrigated agriculture first begin in 3500 B.C.?

2. What property of DDT causes it to remain in lakes and streams over a period of years?
   a. The buoyant nature of the compound.
   b. Its resistance to breakdown by microorganisms.
   c. The solid/compact structure of each molecule.

3. What is a *chinampa* system? Where did it originate?

a. A drainage system.	a. Denver, Colo.
b. A crop rotation system.	b. Canada.
c. Another name for trickle irrigation.	c. Mexico.

4. Large quantities of water are needed to complete the food chain. Approximately how much water is needed to make 1 pound of beefsteak from the start of the cycle when water falls on the plant leaves to the time the beefsteak is made?
   a. 1,000 gallons of water.
   b. 2,500 gallons of water.
   c. 1,300 gallons of water.

5. What occurs when cloud seeding causes rain?

Answers on page 23.

Reservoir Destratification Improves Water Quality

by Reginald G. Howard, Supervisor
Water and Land Operations, Region 2
Sacramento, Calif.

CASITAS Municipal Water District in California has made substantial progress with a new line of attack in meeting water quality problems. Operators are injecting compressed air into Casitas Lake to equalize temperature and dissolve oxygen content. The air is injected about 140 feet from the surface and creates currents, which seem to "stir" the water throughout the reservoir.

The results to the user are cooler water, reduced tastes and odors, reduced organic content, much better chemical quality, reduced costs for quality control, less use of chlorine, and reduced treatment costs to some industries.

A side benefit is the improved fishery in the lake.

The District started experimenting with air injection 4 years ago to eliminate problems caused by high summer temperature of surface waters.

Prior to that time algae growth, spurred by warm surface water and high concentrations of nutrients at the surface, caused taste and odor problems. Users complained.

Treatment to control the algae consisted of copper sulphate and citric acid, applied to the shallower water at a cost of some $20,000 a year.

The theory of injecting air into a lake was not completely new. Others have done it on a smaller scale. It was the first time, however, that a body of water as large as Lake Casitas had been treated successfully.

Casitas Lake is a reservoir built by the U.S. Bureau of Reclamation about 10 miles from Ventura, Calif. When full it covers 2,700 acres, contains 250,000 acre-feet of water and at a maximum is 270 feet deep.

Water service is furnished to agriculture (mostly truck and citrus crops), and municipalities and industry. The latter has increased rapidly as the area has experienced a large influx of industrial development and residential subdivisions. As municipal and industrial uses increase, water quality control becomes more and more important.

Algae growth that causes taste and odor problems is a constant problem in reservoirs, especially in warmer climates.

In summer the lakes stratify; that is, a layer of warmer water forms on top with colder water below. The natural dissolved oxygen is concentrated in the warmer surface waters.

Warm temperatures together with sunlight and high nutrient content encourage algae growth. When the algae begins to die, the resultant taste and odor are objectionable.

Others had discovered that air bubbling to the surface, after being piped to the bottom of the reservoir, creates currents that tend to equalize both water temperature and oxygen content. Accordingly, in 1968 the district started experimenting with air injection.

The operators had many problems. They had to learn about equipment, how to regulate depth and air pressures, and how much air to inject.

They learned by doing. They found, for instance, that air injected at the very bottom created more problems than it cured, by bringing manganese into solution from the bottom sediments.

Water containing appreciable quantities of manganese is undesirable for domestic use because it causes staining of porcelain and laundry.

The air injection system now being used consists of two 315-cubit-foot-per-minute electrically driven compressors. Both are operated continuously from March until October except when one is down for maintenance or servicing.

Air is carried through a 3-inch pipe supported on barrel floats to the deepest part of the lake. Here, four 1-inch hoses lead down to a diffuser system 140 feet below the surface. Air bubbling up from diffuser system makes the lake "boil" over

2- or 3-acre area.

Contrary to what one might think, the effects [o]f this "boil" of water are not confined to the one [s]ite. Imperceptible currents are set into motion [t]hat seem to reach and affect every part of the [l]ake. Samples show that the summer surface tem[p]eratures are some 2 to 3 degrees below pre-treat[m]ent, and deeper temperatures are somewhat [h]igher than before.

Dissolved oxygen is found to depths of 120 feet [t]hroughout the summer, as compared to only 25 [f]eet prior to aeration.

Costwise, the air injection is less expensive than [p]revious treatments of algae with copper sulphate. [A]fter a capital outlay of $19,000, operation and [m]aintenance costs are projected at about $12,000 [a] year.

Surface treatment by copper sulphate, which [c]ost approximately $20,000 per year prior to aera[t]ion was not necessary during the past year.

Due to improved quality of the water, much less [c]hlorine is required for efficient treatment.

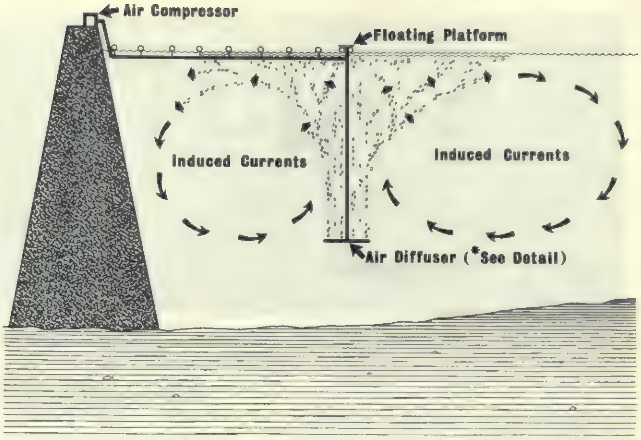
The benefits extend beyond cash costs to the [d]istrict. One industry had spent about $250 a day [f]or chemicals to *remove* oxygen from the water. [N]ow, cost has been reduced considerably because [w]ater with a much lower dissolved oxygen content [i]s selected for use.

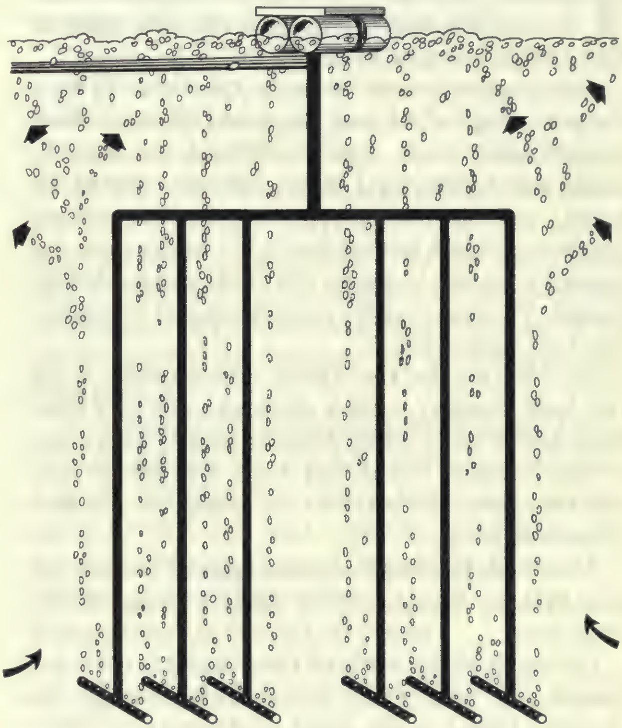
Fishing has been improved. The lake is a favor[i]te spot for campers and fresh water fishermen from the Los Angeles metropolitan area, and 100,000 catchable trout are planted in the lake each year. Since the air injection program began, these fish have thrived.

Trout have shown remarkable growth. Many [t]rout planted as ¼-pound fish now weigh 5 pounds [o]r more.

Whether this system developed by the Casitas District will solve similar problems elsewhere will have to be determined. Obviously, no two situations are exactly alike, nor can their solutions be exactly the same. The success of the Casitas District, however, points to a method that fully merits consideration by others with similar problems.

# # #





***DETAIL OF AIR DIFFUSERS**

Casitas Reservoir Aeration System—Two 315-cubic-foot-per-minute compressors supply air to the system through a 3-inch pipe suspended near the water surface from 55-gallon drums. The air diffuser system is suspended from an 8- by 8-foot platform, plus additional drums not shown in the drawings. The diffuser is made up of 1-inch pipes, 140 feet in length, spaced at 25-foot intervals. The induced currents produced by rising air bubbles are sufficient to "mix" virtually all the water stored in the 240,000-acre-foot reservoir. Care must be used to avoid placing the diffuser too close to the reservoir bottom, possibly disturbing accumulated sediment. In this case, air was released about 70 feet above the bottom.

FIFTY YEARS AGO
in Our Magazine

RECLAMATION RECORD—1922

SALT RIVER PROJECT, ARIZONA

THERE was little demand for irrigation water during the month owing to the cold weather and considerable rainfall.

Two regular crews were in the field. With a daily average of 74 man-days and 32 stock-days, maintenance work was performed as follows: Main canal cleaned, 1 mile; laterals cleaned, 29 miles; old structures repaired, 30; riprapping (stake and brush banks) built, 311 linear feet; dry masonry placed (repairs), 78 cubic yards; dirt fill placed, 570 cubic yards; concrete placed (repairs), one-half cubic yard.

In addition to the above maintenance work, the Ruth dredger, with a daily average of 4 man-days and 4 stock-days, bermed 26,900 linear feet of the Eastern Canal and built 4 miles of road for the machine to travel on along the Eastern Canal bank.

The P. & H. dragline was engaged in berming the Arizona Canal, with a daily average of 1¾ man-days.

Owing to heavy rains of December 31, 1921, and January 1, 1922, Cave Creek broke through the Arizona Canal in the night of January 1, with a flood of approximately 12,000 second-feet. Work was immediately started on making repairs with a crew of 57 men and 64 head of stock; 4,940 cubic yards of sand were removed from the Arizona Canal and 410 cubic yards of dirt fill was made in the Grand Canal. All work was completed within a period of 12 days and water was again running in the Arizona and Grand Canals on January 13, 1922.

The following construction work was achieved during the month, with a daily average of 36 men and 11 stock: Concrete placed, 21½ cubic yards; dry masonry placed, 5 cubic yards; excavation (dirt) made, 615 cubic yards; fill (dirt) made, 102 cubic yards; concrete pipe installed, 468 linear feet; corrugated iron pipe installed, 275 linear feet; redwood headwalls for culverts built, 16; concrete headwalls for culverts built, three new pump laterals built, 3½ miles; 9 by 16 feet standard throw-down bridges built, eight; new well sites fenced, three; mile fence moved, one-fourth mile; redwood turnout installed, one; sand and gravel hauled, 18 cubic yards.

Work was continued on widening the Eastern Canal. The Monighan 2-yard dragline and the Lidgerwood 1½-yard dragline excavated 8,870 cubic yards during the month.

today...

SINCE construction of the Navajo Generating Station began in December 1969, the goals of ts operators have been to meet the power demands of the West and to do so in a manner which will protect the environmental qualities of the area.

The Bureau of Reclamation is a participant because 25 percent of the output will be used for pumping power for the Central Arizona project and because water for the generating station will be supplied from Lake Powell.

Today the $755 million Navajo Power project seeks this goal by allocating $140 million of the $755 million for environmental protection.

The generating station, now under construction, s a 2,310,000-kilowatt coal-fired steam powerplant about 4 miles east of Page, Ariz.

It is being designed to remove 99.5 percent of particulates in the flue gases. Emissions from the station will meet or be less than established limits under Arizona's strict pollution law.

Sulphur oxide removal equipment will also be installed in the station. This is the first large station to have sulphur oxide removal devices. Coal from the Navajo and Hopi Indian Reservations has a lower sulphur content than average. Water pollution will not be a factor, since all cooling water is being recycled and none will be returned to Lake Powell and the Colorado River.

The Navajo powerplant is owned and operated by 5 private and public utilities serving southern California, Nevada, and Arizona and the Bureau of Reclamation. They are the Salt River Project which is constructing, and will operate the plant, the Arizona Public Service Co., the City of Los Angeles, the Nevada Power Co., and the Tucson Gas & Electric Co. The Federal Government has purchased 24.3 percent—561,000 kilowatts—of the plant's generating capacity for the Central Arizona project.

Over the life of the project, the benefits to the Navajo and the Hopi Indian tribes are estimated to be in excess of $70 million from leases, grants, rights-of-way, and coal royalties, plus other economic benefits such as employment preference.

Quite some change has occurred on the Salt River project in the last 50 years!

451-478 O—72——2

Construction of Jackson Lake Dam (summer of 1914), is aided by the cofferdam which holds back the river. Notice the Reclamation Service buildings in the center background.

Recollections on JACKSON LAKE DAM

ompiled by John Markham
Sonora, Calif.

THE growth boom struck Idaho shortly after the turn of the century with a force the ıhabitants would feel for years to come. In 1905 ıe increase in irrigation developments in the Jpper Snake River Valley and the formulation f plans to construct the Twin Falls North Side roject clearly illustrated this growth. But, of ıore immediate importance, these developments lustrated that storage facilities would be required or the Minidoka project in the near future.

The Jackson Lake site in northwestern Wyoıing, at the headwaters of the south fork of the inake River, was adopted for the purpose of proiding such storage facilities. It was decided first ɔ construct a temporary timber dam designed to aise the surface of the lake 10 feet, thus providing storage capacity of 350,000 acre feet, presumably ufficient for irrigation requirements for 4 or 5 ears. This temporary dam would later be replaced y a permanent structure capable of providing reater storage.

The story surrounding the permanent Jackson ake Dam is an interesting one, involving some nteresting people.

In July 1909, two engineers rode horses through Yellowstone National Park seeking a site to build he permanent Jackson Lake Dam to replace the emporary cribwork structure near Moran, Wyo. Frank T. Crowe, Supervising Engineer for the Reclamation Service and a veteran of several Reclamation projects in southwestern Montana, nd his assistant, Robert V. Sass, were the men who completed this assignment for the Reclamaion Service.

These men inspected the site of the temporary lam at Moran, as well as a site about 5 miles away near the confluence of Pacific Creek and the south fork of Snake River. A dam placed here would have damned the Snake River near the south end of the Markham Ranch—now the Jackson Hole Wildlife Park—and would have made Jackson Lake much larger than its present size. (Over 30 years later, in 1940, test holes made in the rock near Pacific Creek were still visible.)

Temporary Dam Fails

On July 5, 1910, about 10 days before stored water was required for irrigation, the middle section of the cribwork of the temporary Jackson Lake Dam failed, releasing 194,000 acre-feet in a flood of 10,000 second feet. Several local bridges and a ferry 40 miles below were damaged but the wave of high water had dissipated by the time it emerged from the canyon.

Careful manipulation of the water in the equalizing reservoir at the Minidoka Diversion Dam prevented any serious damage to the canals or crops of the project.

The situation, however, required immediate action looking to the construction of the permanent storage dam, since an examination of the timber structure disclosed that the wood had rotted and was no longer dependable.

In a letter to me, Harley Coffin of Jackson, Wyo., recalled the event: "The summer the old dam went out, I was working as a helper to the cook whose first name was Ed. On the morning the dam broke we heard a big crash, ran to the door, and saw about 75 feet of the dam go."

Hence, with the survey for the permanent site completed in August 1909, Crowe and Sass returned to Helena, Mont. About 4 years later, Mr. Crowe told Mrs. Joseph J. Markham, my mother, that plans for a new damsite near Pacific Creek

Mrs. Johanna Waldin Markham, the first registered nurse in Jackson Hole, Wyo. (1910).

had been abandoned after compaction tests of the soil showed that the gravel was too loose and the soil too porous to support the weight of a permanent dam. For that reason, the dam was built at the site of the temporary dam at a cost of $453,300. It was completed in October 1916.

Joseph Markham—Timekeeper

Timekeeper, cost keeper and superintendent (July 1910–May 14, 1932) for the building and operation of Jackson Lake Dam was Joseph J. Markham, my father, then only 20 years old. Also serving as the purchasing agent, he bought most of the hay, grain, and beef at Jackson Hole.

Joseph J. McEnroe, a friend of my father, who had traveled West with him from New Britain, Conn., was hired by Mr. Crowe to be the Chief Clerk from July 1910 through July 1911. Mr. McEnroe later became Father's brother-in-law.

Progress Is Evident

Signs of progress were cropping up everywhere. A telephone line from Ashton to Moran was built in early August 1910 and part of the phone line from Squirrel Meadows to Ashton was still being used in 1930.

Douglas Rodeback, who founded the *Jackson Hole Courier* in 1909, estimated the population of Jackson to be 200 at that time, so the estimated 400 men which the Reclamation Service hired in early August and September of 1910 tripled the population of Jackson Hole.

Work crews, an office, and a warehouse were established at Ashton in late July and early August of 1910. Way stations, or overnight stops, were built at Squirrel Meadows, Cascade Creek, and the Snake River ford. By mid-August of 1910 the Reclamation Service at Moran had started the construction of a hospital, four barns, and an office building, plus 19 other buildings, making a total of 25 buildings erected in 1910–11 to house all the men and equipment needed to build the permanent Jackson Lake Dam. Lumber and supplies, including the gates for the dam, were being hauled 75 miles from Ashton to Moran over the 8,429-foot Teton Pass to facilitate the beginning of the dam.

Also in 1910, Mr. Crowe hired Dr. Joseph Hughes Shaw and Miss Johanna E. Waldin to be the first resident physician and nurse at the hospital. Dr. Shaw and Miss Waldin took care of the numerous patients at Moran, as well as many of the local residents of the northern part of Jackson Hole.

Times were so desperately hard in Jackson Hole during the years until 1930 that the residents hardly felt the effects of the depression. Even this national catastrophe didn't change things much in Jackson Hole.

Herbert James McVicker hauling a turbir

Reclamation Service employees and freighters from Ashton worked all winter of 1910–11 for $2.50 per day. Miss Waldin soon married Joseph J. Markham, Sr. Her starting pay as a nurse was $1.25 per week; she later received $90 per month for working every day of the month as the first registered nurse in Jackson Hole.

Nurse Markham did not charge anyone for her help, but one time she delivered a baby, now a prominent cattleman, and was offered a dozen eggs. She said, "I was so surprised, I accepted them." From 1920 to 1932, she treated numerous bear bites on people traveling south from Yellowstone Park to Moran. Every summer there would be several such victims who tried to feed bears in the park.

On December 15, 1910, Robert V. Saas, Sr., married Miss Libby Lzicar, formerly of Crawford, Nebr., and they returned to Moran a few days later. Mrs. Sass told me in her letter of May 7, 1968, that "when the dam was built in 1910–11, Bob was in charge of concrete work. They poured cement in 40 degrees below zero weather and had huge fires going in big stoves to prevent the cement from freezing."

Bob Sass, Jr., mentioned that several packrats chose his parents' home as a winter domicile. After Bob Sr. had tried to trap and shoot them without much luck, he caught several domestic cats that had gone wild and turned them loose in the house

...o to the Ashton Dam in August 1916.

Joseph James Markham, timekeeper, cost keeper and superintendent for the building of Jackson Lake Dam.

to prey upon the rats. Unfortunately, the cats ran wild inside the house; then Mr. Sass had the problem of getting rid of both the cats and the rats.

Wild game and fish were easily obtained and trought could be caught from any stream large enough to water a horse. This lasted until 1940; then the catch began to decrease. During the construction period between 1910 and 1911, one could catch numbers of Mackinaw trout in Jackson Lake and could keep them fresh by simply laying them in any convenient large snowbank—the "pioneer deep freeze."

Large Freight Haul

In mid-October 1911, Joseph Hollis "Hall" Egbert, who had been hired to supervise all freighting from Ashton to Moran, his son Russ, and a crew of freighters hauled the gears to a hoisting engine and a carriage track weighing 8,200 and 5,500 pounds, respectively, in one of the classic freight hauls of all time.

In 1914, another important freighting took place when Hall Egbert, Will Steingraber, and John Blanchard of Victor, Idaho, and a crew of freight men hauled six huge boilers over the Teton Pass through snow 15 feet deep. Temperatures went as low as 63 degrees below zero in February, but work on the dam continued year round.

Robert V. Sass found trout plentiful in Jackson Lake in 1914.

In May 1914, a sawmill was started at Moran to build forms for cement work and to house personnel who worked on the "third"* Jackson Lake Dam.

Unfortunately, the mill was destroyed by a fire of unknown origin just a short time later. Edward Trafton, who worked at various jobs including working at the sawmill, was accused of burning down the sawmill, but this was never proven. Interestingly enough, however, Trafton was later convicted of robbing several stagecoaches in Yellowstone National Park.

Soon after the burning of the sawmill, it was rebuilt and operated through October 1916. I was later told that the mill had to be closed during the winter of 1914 through the winter of 1916 because the logs which floated across Jackson Lake during those years froze so hard they could not be sawed.

Balderston Narrative

William Balderston, a family friend since May 1914, gives an interesting account of some of his experiences relative to building of the "third" Jackson Lake Dam from 1914 to 1915.

He lived in his native town of Boise, Idaho, and spent most of his summers during his high school years working with surveying crews in the southern part of the state. In 1914, he received an appointment to West Point from Senator William E. Borah, but did not enter because of his father's death.

"Our family had a close friend," wrote Balderston, "who lived near us in Boise, A. J. Wiley. He was a well-known consulting civil engineer. He had done much work for the Reclamation Service and it was through his office that I first secured a job as a rodman on a surveying crew at the Jackson Lake enlargement project.

"I will never forget the first time we got a full view of the magnificent Teton Range as we worked our way up the valley. It made such an impression on me that when I got back to the University of Wisconsin 2 years later, I wrote a theme in my English class describing the trip and my professor was so impressed with my description of the Teton Mountains that he put me in the advanced English class.

"After I left the dam in the fall of 1915 and took a sheep train back to Madison, Wis., to attend the University of Wisconsin Civil Engineering College, I met my future wife, Susan B. Ramsey, whose mother has always said that I wooed and won her by my tales of Jackson Hole."

Mr. Balderston also described some of the construction work: "During construction of the enlargement of the dam it became necessary to 'shoot out' the west wing wall of the old dam. To do this, a whole crew of 'power monkeys' had to drill the entire face of the wing wall at intervals of 18 inches with hand drills and load each hole

The dam succeeds in holding back the Snake River.

*The "second" or permanent Jackson Lake Dam, built in 1910–11, replaced the temporary Jackson Lake Dam, built in 1906–07; the "third" Jackson Lake Dam was an enlargement of the "second" dam.

Early stages of construction of the permanent Jackson Lake Dam.

vith dynamite. When it came time to set off the harge, a group of us, including Frank Banks, later to be Construction Engineer for Grand Coulee Dam) got under the sluice tunnel under the ld dam. The chief powder man came into the unnel, pushed the handle and set off a terrific harge, which nearly deafened everyone in the unnel. After the 'shot,' nothing was left of the ving wall but the reinforcing steel."

Balderston had been seen around camp with small camera, and was appointed official progress hotographer for the construction project. He aid, "I designed and, with the help of a carpener, built probably the first darkroom in Jackson Hole and started taking progress pictures for the Government."

Beaver Poacher

Balderston also wrote: "Beaver Tooth Neal was frequent visitor in the camp and was of great nterest to everyone because he was such a charcter and had a reputation as a beaver poacher. The game wardens used to catch up with him uite often and he had to resort to special tactics o get his illegal skins out of the valley.

"The story was told that at one point, two officials of the dam were headed out to Ashton over he Reclamation road. Beaver Tooth asked them f they would take out his bedroll as he was going out on horseback and did not have room for it. They willingly took the bedroll out and left it at he warehouse in Ashton, whereupon Beaver Tooth came in a few days later and picked up the 'bedroll.' It was discovered to be pretty well filled with beaver skins."

Only 75 months after the first work began on the permanent Jackson Lake Dam, the dam as well as the 45 Reclamation Service buildings were completed. This marked the end of a thrilling era—an era which resulted in greatly improved water facilities.

"It was not until 1948," Balderston wrote me, "33 years later, that I was able to return to Jackson Hole with my wife and our two sons. There had been a great many changes, but thanks to the foresight and generosity of the Rockefeller family, the natural beauty of the valley had been preserved for all Americans to enjoy."

The Rockefeller family was instrumental in creation of the Teton National Park, the boundaries of which include the Bureau of Reclamation reservoir, Jackson Lake. * * *

Lower face of Jackson Lake Dam.

An aerial view of Jackson Lake Dam and Reservoir at the base of the Teton Mountain Range as they look today.

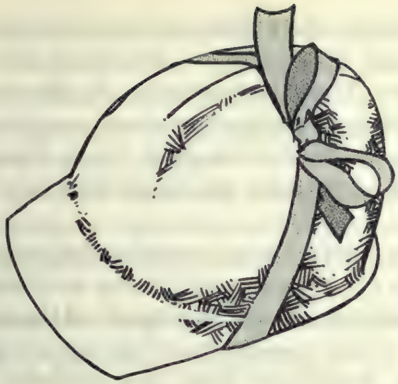
The stories conveyed to us through John Markham's papers, dealing with the construction of the temporary, permanent, and third Jackson Lake Dams, portray a myriad of interesting personalities. It is to these people that we owe a great deal. As a result of their willingness to work under the most extreme conditions, we now have the enlarged Jackson Lake and the many benefits it holds for us today.

Jackson Lake has been a major contributor to the Minidoka project's crop production. Since 1909, it has aided in the production of over \$3⅓ billion worth of crops. As a recreational facility, Jackson Lake has excelled as a part of Teton National Park. In 1970 alone, this park hosted tourists for nearly 4 million visitor-days which included such activities as sightseeing, picnicking, camping, swimming, waterskiing, boating, and fishing.

The effectiveness of the lake is partially due to the ability of the Bureau to maintain it at an appropriate and useable level during the park tourist season. Early each spring prior to the snowmelt, the dam's gates are opened for drawdown. This provides the reservoir with additional space to accommodate the spring snowmelt which occurs in May and June. Since controlled amounts of water are released downstream, floods are averted.

After the May–June refill, the lake's surface is lowered slightly in July, August, and September (approximately 6 feet prior to Labor Day and another 4 feet after the holiday). The lake level is then stabilized from the first of October until spring.

This controlling of the level does not seriously affect boating or any other water sport on the lake. It merely prevents flooding during the peak runoff periods. # # #



A RIBBON ON MY HARD HAT

WHAT do a civil engineer, a hydraulic engineering technician, a fiscal officer, a technical editor-writer, and a geologist have in common? Generally little, but a particular group of such individuals have much in common—they all are women and all are employees of the Bureau of Reclamation.

Therefore, those who still believe a woman's proper place is only in the home had better take a second look at what is being achieved by these females who share their talents and energies with the Bureau of Reclamation. The projects these women help to design, construct, and operate have aided water users for years by developing western water and land resources.

The Civil Engineer

In 1948, shortly after the Bureau opened its Upper Missouri Projects Office in Great Falls, Mont. (Region 6) it hired a young civil engineering graduate from the University of Texas. Lucy Pettapiece has since worked on a number of assignments in that office.

Until recently, almost all of these assignments were concerned with bringing irrigation water to the arid lands of Montana. When she arrived, studies were in progress on the proposed Lower Marias Unit in central Montana. Tiber Dam was constructed to impound a water supply for the Unit. However, plans for completion of the Unit had not been finalized; Lucy took part in completing them. This included laying out proposed canals and laterals, selecting structure sites, preparing designs, and estimating quantities of material needed and the costs of construction.

20 Years Later

In 1968, the Bureau completed a storage dam for the Bureau of Indian Affairs 4 miles northwest

Lucy Pettapiece points out a transverse groove designed to control cracking in slipform concrete lateral lining on the Helena Valley Unit. The lining was installed to cut water losses from an existing lateral.

Lower Two Medicine Dam, Mont.

of East Glacier, Mont. The structure on Two Medicine Creek replaces a dam washed out during the floods of 1964. Civil engineers, including Lucy, worked hard to obtain survey data necessary to plan recontruction of the destroyed dam.

Runoff from a portion of Glacier National Park is regulated at Lower Two Medicine Dam for irrigation of approximately 23,000 acres in the Blackfeet Indian Reservation. Two gates in the overflow weir of the spillway release stored water for downstream diversion throughout the project area.

Other portions of Lucy's time has been spent on drafting annual construction contracts for installing buried membrane lining in canals on the Bureau's East Bench and Helena Valley Units.

This lining reduces water losses from the canals and, in the construction of drains, prevents water logging of the units' irrigated lands. New to these units, a program was started to install slipform concrete lining in the laterals.

The 63-foot-wide polyvinyl chloride membrane used on these projects was unfolded from the canal bottom and laid up the 2:1 slope, one side at a time. The loose sides are covered with material at the excavated 18-inch-wide anchor berm. Placement of selected cover material is made with a dragline to a depth of 16 inches. This PVC lining often runs nearly 800 feet long.

Now in the Design Branch of the Upper Missouri Projects Office, Lucy has been busy writing the construction specifications under which this construction work is performed.

In addition, she worked on recent studies to de termine the feasibility of diverting the unuse water from Tiber Reservoir on the Marias Rive into the Milk River to supplement supplies on th old Reclamation Service Milk River Project an to provide irrigation for lands between the tw rivers.

Canyon Ferry Dam is another major structur for which Lucy made preliminary studies, such a determining the back water curves of the reservoi She also wrote specifications for removing grave and rock fragments from the spillway stillin basin of the dam.

Lucy sees the Bureau as being far more diversi fied than it was years ago. "Almost since its be ginning as the Reclamation Service, the Bureau o Reclamation has been primarily interested in i

East Bench Canal, Mont.

rigation, with power production and flood contr as byproducts of its operations. Now its goals a broadening, and irrigation is just a part of th whole of the many benefits the Bureau produces.

"Among water uses to be considered are munic pal as well as industrial supplies. Interest in d veloping the large coal deposits of southeaster Montana and northeastern Wyoming plunged th Upper Missouri Projects Office into studies of th feasibility of using large-diameter pipelines t transport water hundreds of miles from Burea reservoirs to coal fields, where a regulated wat supply is vital to development.

"As another aspect of the diversified Burea UMPO is evaluating the needs, resources, and d

elopment possibilities of the sparsely populated astern Montana. After development possibilities ave been determined, studies will be made of ethods and costs of developing these resources f which water is only one.

"This diversification of Bureau interests, in conunction with its competent and experienced engieering staff, can lead to undreamed of new goals."

he Hydraulic Engineering Technician

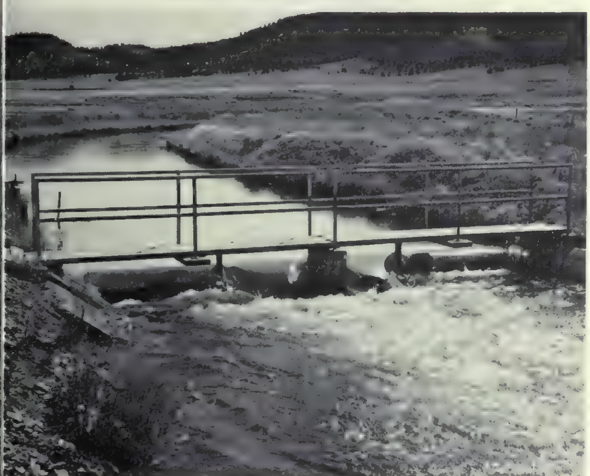
Learning why a particular canal has a 3-foot adial gate and another has a 4-foot rectangular ate, why Yuma is concerned about stormflows, nd why a certain vehicle has two fan belts are nly a few of the things one learns when one becomes a hydraulic engineering technician.

Ruth M. Funk, a hydraulic engineering technician in region 3 at the Yuma Projects Office has ot only learned much from her job, but has been iven ample opportunity to apply her knowledge.

The responsibilities of the Water and Land peration Division which directly concern her nclude: A deep well pump drainage program. ne objective of this program is to maintain safe round-water levels in the area and to coordinate ne drainage flows and the salinity levels of these ows with the requirements of water to be devered to Mexico. The drainage wells are in the Velton-Mohawk, South Gila Valley and Yuma lesa areas.

Delivery of irrigation water to farms on Bureauperated irrigation systems is another objective of ne program. This includes processing water rders, preparing water delivery schedules, operating water delivery and distribution systems, and maintaining water accounting records. Also included is the scheduling of requirements for water diverted at Imperial Dam for the irrigation records required by the Supreme Court decree in the case of *Arizona* v. *California*. And, finally, this includes performing hydrographic activities such as reading water-stage records; measuring flow of canals, laterals, sluiceways, and drains; measuring discharge flows from drainage wells and channels and making the required hydraulic computations and reports.

Helena Valley Canal, Mont.



Her final responsibility is involved with the maintenance of facilities at Imperial and Laguna Dams, Senator Wash Dam and Pump-Generating Plant, and Bureau-operated facilities of the Gila and Yuma projects.

As a hydraulic engineering technician, Ruth supervises the preparation of various recurring and special reports, which include data on flow and diversion, return flows, power and operation, and a variety of hydrographic records. She prepares a schedule of water requirements for weekly irrigation for diversion at Imperial Dam for both Government and water district operated projects consisting of approximately 180,000 acres—comprised of five irrigation districts and two Bureau-operated units. She also maintains hydrographic records of daily operations by the districts and Bureau-operated units, including waste, usage, rejected orders, etc.

"I had absolutely no idea what the functions of the USBR were when I began working for them," said Ruth. "But, since I have an insatiable curiosity about most everything of which I am not knowledgeable, the Bureau opened the doors for me to a vast unknown world of maintenance, construction, engineering, irrigation, administration, heavy-duty mobile equipment, rivers, dams, etc. Do I like my job? Believe me—I love it!"

The Fiscal Officer

Nedra A. Blackwell, Chief of the Fiscal Services Branch in Region 1, finds working for the Bureau a rewarding and challenging experience. Although most people think of Reclamation as being a man's world of engineers, the world of finance in Region 1 is mostly populated by women. Moreover, Nedra has the distinction of being the first female fiscal officer in Region 1.

She is responsible for certification and payment of all claims for Region 1 and all collections from

Nedra A. Blackwell, Chief of the Fiscal Services Branch in Region 1, completes a voucher sheet.

repayment contracts, and water and power sales. The payroll is also a major part of the Fiscal Services Branch and the changes it has undergone from a manual operation to data processing have been of prime interest to her. Her monthly reconciliation of fund control accounts with the Treasury Department and the Regional General Accounts Branch always presents a satisfying conclusion to the month's activity—particularly if they balance on the first try!

Whether certifying a $4 million contract payment, a $10 travel voucher, or attempting to interpret Comptroller General decisions, Nedra approaches each task with enthusiasm and sound judgment. "I am proud of being a part of Reclamation and particularly proud that Reclamation is one Government agency which directly benefits the people and is nearly self-supporting from the income derived from contract repayments and water and power sales."

The Technical Editor-Writer

Filling a position that ranges from editing test plans and reports at Dugway Proving Ground, Dugway, Utah to preparing environmental statements for each unit of the Central Utah project is an exciting career for Diane L. Jarvis.

A technical writer translates the technical language of the scientist or engineer into terms understandable to the layman. "A rewarding aspect of my job is knowing that with each finished project I've contributed to the establishment of a easier communication between scientists and engineers and laymen," commented Diane.

"My work with the Bureau has been especiall interesting and challenging. With each new assignment, I'm presented with an opportunity t increase my knowledge in many categories. Fo example, our branch has been responsible for writing definite plan reports for the six units of th complex and multipurpose Central Utah projec (Region 4), a participating project of the Uppe Colorado River Storage project.

"Another challenge is the environmental statements we have been working on which define an assess the impacts the project will have on th area's environment. Policies and guidelines fo these statements are in the formative stage an much of the groundwork is still being laid. It i exciting to participate in this quest for quality which is so important to present and futur generations."

The Geologist

A 1968 graduate of St. Louis University Frances J. Landwehr came to work for the Burea at Grand Coulee Third Powerplant in Septembe following her graduation.

Since that time her work has consisted of variety of outdoor and indoor activities. "Outdoors," explains Frances, "I work on detaile geologic investigations of the construction site an surrounding area. This includes mapping the lan as excavation progresses, identifying and evaluating soil and rock types for geologic condition an content, inspecting drilling operations, and logging core. I also work on selecting base material for fill placement.

"Indoors, there is preparation of the interpretations and exploration results. I also compile dat for monthly geological and final constructio reports.

"I enjoy working both indoors and outdoors When there is adverse weather, one finds something inside to do, and when the weather is nice one looks for something outside. Then there ar those times when you end up outdoors in a blizzard, but that is OK, too!!"

When she first arrived at the geology department, there were approximately 30 drillers an drill helpers. Most of them were apprehensive during her first day in the field, but after numerou stares and much laughter, they began to accept he

Other geologists claim they can scream for help hile hanging from a cliff by their fingernails and one will notice, but Frances stumbles and every-e looks. "They exaggerate a bit, but I do believe am probably one of the few geologists who can nvince a driller to carry core boxes for me.

"On the whole, most of the people I associate th accept me as I am. There are some, however, ho don't know I'm a geologist and wonder why always wear jeans. One man, after seeing my sk, asked where my typewriter was.

"I get a lot of ribbing, but I enjoy the work ry much. If I didn't, I wouldn't be here," she mmarized.

clamation's Diversified Ladies

Far from being stereotyped, many of Reclama-n's females are extremely diversified. They, as ll as numerous others in different fields, all con-ibute to the Reclamation program. Our hats, hether hard or soft, with or without ribbons, are to these ladies. # # #

Diane L. Jarvis, Technical Editor at Dugway Proving Ground, Dugway, Utah, finds her job challenging and rewarding.

Canyon Ferry Dam, Mont., unlike most other dams, knew the touch of a female civil engineer.

NEWS NOTES

Navajo Project Environmental Draft

A draft of a consolidated environmental statement for the Navajo thermal-electric project in Arizona, Utah, and Nevada has been released by the Department of the Interior.

Commissioner of Reclamation Ellis L. Armstrong said the draft covers all aspects of the project, including the Navajo Generating Station, the Black Mesa, and Lake Powell Railroad (formerly called the Navajo-Black Mesa Coal Haul Railroad), the Black Mesa Coal Mining Operation, the Southern Transmission System (formerly called the Navajo-Phoenix Transmission System), and the Western Transmission System (formerly called the Navajo-McCullough Transmission Line).

Prepared in compliance with the National Environmental Policy Act of 1969, a consolidated final statement will be submitted to the Council on Environmental Quality following review of the draft by Federal, State, local, and private agencies, including conservation and environmental groups.

The consolidated draft statement is a cooperative effort involving the Bureau of Reclamation and the latter groups.

Illinois U. Gets Skywater Contract

The Bureau of Reclamation has awarded a 5-year contract to the University of Illinois for research and planning of future programs of precipitation management designed to increase water supplies and crop moisture in southern Illinois.

The Commissioner explained that the contract is a significant step in Interior's development of a national program of atmospheric water resources research and is being undertaken as a part of the Bureau's Project Skywater effort to develop clou
seeding as an efficient water resources tool.

The work will be directed by Stanley A. Chan
non, Jr., head of the Atmospheric Sciences Secti
of the Illinois State Water Survey.

"This project achieves two significant firsts
the Commissioner explained. "It is the first co
prehensive investigation of cloud-seeding potenti
in the Midwest, and it represents the first basic r
search of the treatment of winter storms over no
mountainous areas to recharge soil moisture a
shallow groundwater aquifers."

SRP Presented Certificate

During his visit to the Salt River project
November 8, while accompanying Spain's Minist
of Public Works Gonzalo Fernandez de la Mo
Commissioner Armstrong presented a special Ce
tificate of Appreciation to the personnel of t
Salt River project, signed by Secretary of Sta
William P. Rogers and Secretary of the Interi
Rogers C. B. Morton. Both expressed their a
preciation for the outstanding record of hospit
ity and technical training which the project h
offered the many foreign visitors to Arizona.

Nelson U.S. Representative

Harold T. Nelson, former Regional Direct
Boise, Idaho, has been appointed U.S. Represe
ative to the Columbia Basin Interstate Comp
Commission by President Nixon. Nelson succee
Thomas R. Newell, who resigned.

Commissioner Armstrong said Nelson's prof
sional experience and background, including p
sonal knowledge of water problems of the ar
make him admirably suited to be the Federal r
resentative in deliberations of the Commission.

The Commission was authorized by the Congr
in the early 1950's to negotiate and enter int
compact for the disposition, allocation, diversi
and apportionment of the waters of the Colum
Basin and its tributaries.

More Plastic Tubing

During the week of October 18–22, about 4,000 feet of corrugated plastic drain tubing (6 and 8 inch diameter) was installed on proposed irrigable land in the Oakes Area, N. Dakota. This work was performed by Eli Hershberger, Inc., with a continuous chain trencher. Mr. Hershberger said the machine used for this job is capable of laying pipe to a depth of 6 feet. The conditions encountered here are quite representative of those on the Garrison Diversion Unit. Part of this drain will have a gravel envelope and part will not. (Editor's Note: In the November 1971 issue of the *Era*, an article titled "Region 7 Launches Program To Reduce Subsurface Drainage Costs," gives a full account of what Region 7 has done with this type of plastic tubing).

Howell Joins Reclamation

Dr. Wallace E. Howell, distinguished meteorologist, inventor, and scientific director of the Mount Washington Observatory in New Hampshire, joined the staff of the Bureau of Reclamation's Engineering and Research Center at Denver, Colo., in November.

Dr. Howell, 57, now heads the Research and Development Branch of the Bureau's Division of Atmospheric Water Resources Management.

Dr. Howell has been a private consulting meteorologist with offices at Lexington, Mass., in addition to his post as scientific director and former president of the Mount Washington Observatory. The observatory is a private, nonprofit institution where cloud physics and icing research studies have been in progress since World War II.

As founder and principal officer of a meteorologic firm then bearing his name, Dr. Howell directed the operation of some 60 weather modification projects in the eastern United States and Canada and in a dozen foreign nations from 1951 to 1967. His firm also pioneered a number of cloud-seeding techniques before a corporate merger in 1967.

Dr. Howell recently invented a radically new type of anemometer based on its ability to sense the momentum of moving air. He holds two patents on instruments used in meteorologic work. He has authored more than 50 technical papers and publications on the science of meteorology, and in 1968 was honored by the American Meteorologic Society for outstanding contributions to applied meteorology.

Elephant Butte Makes Final Repayment

This 102,082-irrigable-acre irrigation district, one of the first Reclamation projects to be authorized, made its final repayment in September 1971.

Initially authorized on March 4, 1907, under the provisions of the Reclamation Act of 1902, the total project cost was $6,551,330.

In June 1918, the Elephant Butte Irrigation District assumed obligations of the Elephant Butte Water Users Association. This included the costs of the irrigation facilities in New Mexico and a portion of the costs of Elephant Butte Dam. By contract dated November 9, 1937, the district was relieved from repayment of the cost of Elephant Butte Dam in return for relinquishement of its interest in power development.

Repayment charges were spread over 40 years from the date the first installment became due under the original contract, exclusive of several years of moratorium. The first payment was due March 1, 1923, and the final payment was due September 1, 1971. The project is now paid in full.

# # #

Answers To Water Quiz:

1—Tigris-Euphrates Valley in Mesopotamia and Nile Valley of Egypt. 2—b. 3—a, c. 4—c. 5—Salt particles unite with supercooled water droplets, causing both an increase in the size of the cloud and measurably greater rainfall than from nonseeded clouds.

MAJOR CONSTRUCTION AND MATERIALS FOR WHICH BIDS WILL BE REQUESTED THROUGH FEBRUARY 1972*

Project	Description of work or material
Central Utah, Utah.	Constructing Currant Creek Dam, a zoned earthfill structure about 130 ft high and 1,600 ft long. The outlet works will consist of an intake structure, a 12-ft diameter, steel-lined conduit, a gate chamber and shaft, a 16-ft 9-in. diameter horseshoe conduit with a 12-ft diameter steel pipe, a control structure, and a stilling basin. The outlet works will discharge to a 10-ft 6-in. diameter buried pipeline. The spillway will consist of an inlet structure and a 10- by 20-ft conduit on the dam embankment, and a stilling basin with a service bridge. Work will also include improving 3.3 miles of road, constructing 0.6 mile of road, and constructing a boat ramp. On Currant Creek, about 13 miles northwest by road from the Currant Creek crossing of U.S. Highway No. 40, in Wasatch County, Utah.
Central Valley, Calif.	Constructing about 87 miles of pipelines ranging in size from 12 through 72 in. in diameter with heads varying from 25 through 225 ft, 7 pumping plants, 1 water screen and recirculating structure; and installing 40 vertical-shaft pumping units with a capacity range of 21 to 2.8 cfs with heads up to 150 ft. Work at the pumping plants will include furnishing and installing pumping units, motor control equipment, traveling and stationary water screens, gate valves, check valves, steel manifolds, air chambers, and watermeters and structures. Near Huron. Westlands Pipe Distribution System Contract No. 10, Laterals 28–2.0, 29–1.0, 30, 32, 33, 35, 37, 2R, 13R, and 17R.
Do	Constructing about 5.2 miles of unreinforced concrete-lined canal with a 12-ft bottom width and a capacity varying from 725 to 425 cfs. Work will include constructing two 102-in. diameter precast concrete siphons; three bridge crossings; three turnout structures; five overhead steel pipe cross-drainage structures; one culvert cross-drainage structure with stilling pool; one reservoir inlet structure; three oil and gas line crossings; and three irrigation crossings. About 5 miles northeast of Coalinga, Coalinga Canal, Reach 2.
Do	Disassembly and reassembly of six main pumping units; machine work necessary for modification of the lower pump bearing on each unit; and provision for four handholes and one manhole for each unit. Thirteen miles west of Los Banos, O'Neill Pumping plant.
Do	Furnishing and placing creek run cobble fill and riprap blanket of undertermined length along the west shoreline of Red Bluff Reservoir, and providing about 80,000 sq ft of slope protection at the Tehama-Colusa Canal settling basin. Two miles southeast of Red Bluff.
Do	Furnishing, installing, and testing one 13.8-kv armature winding for a 60,000-kva generator, Folsom Powerplant.
Columbia Basin, Wash.	Constructing 13 miles of buried pipe drains and one pumping plant. Fifteen miles northwest of Pasco, Block 16.
Do	Constructing 2.1 miles of concrete-lined canal with a bottom width of 10 ft; 19.5 miles of concrete-lined laterals with bottom widths of 4 and 2 ft; and 11 miles of unlined drains and wasteways with bottom widths of 6 and 4 ft. Pipe work will consist of 3,600 ft of 51-in. and 3,000 ft of 48-in. diameter precast concrete pressure pipe with a maximum working head of 75 ft; and 5,000 ft of 36-in. diameter and smaller precast concrete pressure pipe. Thirty-five miles west of Othello. Priest Rapids and Block 251 Laterals, Station 2347+91.1 to Station 2461+54.5.
Do	Constructing about 2.2 miles of gravel-lined "V" type channel with appurtenant structures for highway and railway crossings to serve as a wasteway for WB38B lateral, and modifying a check structure on Wahluke Branch Canal, Block 25, east of Mattawa.
Do	Constructing 2.6 miles of 30-ft bottom width unlined channel with rock-lined drop structures and drain inlets; furnishing and installing 1.5 miles of Type B barbed wire fencing; and grass seeding banks. Three miles southwest of Eltopia. Esquatzel Coulee.
Do	Constructing concrete foundations; furnishing and erecting steel structures; installing a 15-kv primary unit substation; furnishing and installing two 115-kv circuit breakers, and associated electrical equipment; constructing about 2 miles of concrete-encased duct bank; furnishing and installing about 4 miles of 11.95-kv feeder circuit in duct bank and about 3 miles of direct-buried 11.95-kv feeder circuits; modifying existing switchyard; and grading, surfacing, and fencing an extension to the yard. Left abutment area of Grand Coulee Dam. Grand Coulee 115- and 11.95-kv switchyards and 11.95-kv feeder circuits.
Do	Control boards for control of the 500-kv switchyard and generator units G19, G20, and G21, Grand Coulee Third Powerplant.
Central Valley, Calif.	Five modification assemblies for existing governors, including governor control columns with associated equipment, permanent magnet generators, necessary controls for operating from a remote control baord, and governor instrument panels for mounting on existing actuator cabinets. Shasta Powerplant.
Fort Peck, Mont.	One 2-channel, single-sideband carrier-current system between Dawson County and Custer Substations.
Fruitland-Mesa, Colo.	Constructing 13 small reinforced concrete structures and 0.56 mile of earth-lined canals with bottom widths of 10 and 8 ft; and furnishing and laying 2,730 ft of 24- and 30-in. precast concrete culvert pipe with Type R joints, 1,345 ft of 30-in. precast concrete pressure pipe with a maximum head of 150 ft, and 1,575 ft of 42-in. precast concrete pressure pipe with a maximum head of 225 ft. Nine and 13 miles southwest of Crawford. Gould Canal, Siphon Replacements.
Fryingpan-Arkansas, Colo.	Constructing Pueblo Dam, a zoned earthfill and concrete structure about 190 ft high, 10,000 ft long, with a concrete stilling basin about 550 ft long. The major excavation for the concrete and earth embankment sections for the dam was performed under a prior contract, leaving only minor rock and common excavation to be performed. Normal diversion of the river will be accomplished by passing the flow of the river through two diversion conduits built into the existing concrete plug constructed in the river gorge. The concrete portion will consist of 23 massive-head buttresses with an uncontrolled central spillway, totaling 1,750 ft in length. Drilling and grouting of the foundation rock of the concrete dam and stilling basin will be followed by drilling of drainage holes. The structure will contain six outlets controlled by high-pressure gates. Earth dam embankments, predominantly rolled earthfill, which wrap around the ends of the concrete dam are to be constructed, totaling about 8,450 ft in length. All cutoff trench construction beneath the earth embankments was completed in the prior contract. The zoned earthfill embankments will have a downstream face layer of sand, gravel, and cobbles with tow drain systems. The upstream faces will be covered by riprap. A concrete shaft and shafthouse will be constructed in the right abutment of the earth dam. On the Arkansas River, about 8 miles west of Pueblo.
Do	Improving 3 miles of county road by widening roadway to 22 ft, placing 6-in. surface of select roadway material, installing corrugated-metal-pipe culverts and extending existing corrugated-metal-pipe culverts; constructing a 22-ft wide, 25-ft long reinforced concrete slab bridge and widening existing stone masonry abutments. Thirty miles east of Basalt.
Lyman, Wyo.	Constructing the zoned earth and rock fill China Meadows Dam with a height of about 105 ft above the bed of the river, and a crest length of about 2,350 ft; a dike about 43 ft high with a crest length of about 1,000 ft; a reinforced concrete outlet works structure consisting of a 5.5-ft diameter diversion conduit, 150 ft long; an intake structure; a 5.5-ft diameter, steel-lined upstream conduit, 170 ft long; a gate chamber housing a 2-ft 9-in. by 2-ft 9-in., high-pressure, emergency slide gate; a 7-ft diameter, horseshoe-shaped, downstream conduit containing a 36-in. inside-diameter, steel outlet pipe 380 ft long; a control structure and house with a 2-ft 9-in. by 2-ft 9-in., high-pressure, control slide gate; a rectangular stilling basin 45 ft long, 10 ft wide, and 19 ft deep, which will empty into a riprap-lined outlet channel; a 16-in. diameter bypass pipe from the outlet works to a 14-in. diameter, jet-flow gate; and 8-in. diameter bypass pipe connected to 16-in. pipe leads into a 12-in. diameter precast concrete pipe placed in a back-filled trench, 6,300 ft long; a reinforced concrete spillway structure consisting of a 70-ft long, side channel, overflow crest; a 420-ft long rectangular chute varying from 18 to 32.5 ft wide; a rectangular stilling basin 102 ft long, 32.5 wide, and 31 ft deep, which will empty into a riprap-lined outlet channel; and a gravel-surfaced access road to the damsite and a gravel-surfaced access road between the dam and the dike. On the East Fork of Smith's Fork River, about 25 miles south of Mountain View, Wyo., in Utah.
Mountain Park, Okla.	Constructing a bridge, and earthwork, corrugated-metal pipe and concrete box culverts, guardrail, fencing, and bituminous surfacing for 5.1 miles of relocated highway. The bridge, to cross Glen Creek, will have a 40-ft roadway between barriers, two 70-ft 6-in. continuous spans using rolled beam sections and a 6.5-in. reinforced concrete deck, and a superstructure supported on timber pile footings at the abutments and center pier. Beginning about 4.5 miles north of Mountain Park, U.S. Highway No. 183 and Glen Creek Bridge.
Do	Constructing an access road to the Mountain Park damsite. Near Snyder.
Pick-Sloan Mo., Kans.	Constructing about 4.7 miles of 6-in. subsurface drain varying in depth to 11 ft; about 1.6 miles of open drain with bottom widths varying from 6 to 4 ft; 20 concrete manholes; and 8 corrugated-metal-pipe outlet structures. About 2 miles north of Courtland. Courtland 31-2–5.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 451-4

MAJOR CONSTRUCTION AND MATERIALS FOR WHICH BIDS WILL BE REQUESTED THROUGH FEBRUARY 1972 *—Con.

Project	Description of work or material
Pick-Sloan Mo., Kans.	Constructing about 4.2 miles of 6- to 12-in. subsurface drains varying in depth to 11 ft, 23 concrete manholes, and 3 corrugated-metal-pipe outlets. Six- and eight-in. corrugated-plastic drainpipe will be an alternate to concrete, clay, or asbestos-cement pipe for 2.3 miles of drain. About 4 miles south of Republic. White Rock 30-2-4.
Pick-Sloan Mo., Mont.	Constructing about 4.1 miles of dikes with a maximum height of 15 ft along the west side of the upper end of Canyon Ferry Lake. Near Townsend.
Pick-Sloan Mo., Nebr.	Stage 03 additions to Stegall Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing a 3-phase, 230-kv, 25-mva reactor, and related electrical equipment. About 14 miles west of Gering and 3 miles south of Stegall.
Pick-Sloan Mo., N. Dak.	Constructing 20 miles of 1,950-cfs capacity canal with a 25-ft bottom width and side slopes of 2:1; a headworks structure with eight 120- by 120-in. cast-iron slide gates with motorized lifts and a 12- by 23-ft control house; a check structure with two 16-ft radial gates with motorized lifts; a structural-steel railroad bridge with concrete abutments; five highway bridges with precast-prestressed concrete abutments; five highway bridges with precast-prestressed concrete beams; 850 lin ft of 18- to 84-in. diameter corrugated-metal pipe; five turnout structures with chute outlets; berm drainage structures; cross drainage structures; highway and county road relocations; and a concrete rating section. Near Turtle Lake, McClusky, Reach 1.
Do	Constructing 16 miles of 1,950-cfs capacity canal with a 25-ft bottom width and side slopes of 2:1; five 20-cfs capacity turnouts; berm drainage structures; a 24-in. diameter cross-drainage structure; three bridges to be continuous structures consisting of two 53-ft 6-in. spans, one with a roadway width of 32 ft and the other two with 28-ft roadways; superstructures to be reinforced concrete deck slabs supported on precast-prestressed concrete box girders; substructures consisting of concrete solid wall piers and abutments,
Pick-Sloan Mo. N. Dak.	each supported on timber piles. Work will also include road construction consisting of 3 miles of gravel-surfaced county road relocation and 1.8 miles of bridge approach roads. The bridge approach roads are to be surfaced by gravel for about 1.3 miles and 0.5 mile with bituminous base. Near Turtle Lake, McClusky, Reach 2.
Pick-Sloan Mo., N. Dak.	Stage 04 additions to Carrington Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; removing and reerecting a steel structure; relocating one 46-kv circuit breaker; furnishing and installing one 5.4-mvar shunt capacitor equipment bank, on 46-kv circuit breaker, and associated electrical equipment; and grading, surfacing, and fencing an extension to the yard. Stage 03 additions to Leeds Substation will consist of constructing concrete foundations; furnishing and erecting a steel structure; removing and reerecting steel structures; furnishing and installing one 5.4-mvar shunt capacitor equipment bank, one 69-kv circuit breaker, and associated electrical equipment. Carrington Substation is just northeast of Carrington; Leeds Substation is about 2.5 miles south of Leeds.
Do	Furnishing and laying about 3.3 miles of 27- and 30-in. diameter pressure pipe with heads ranging from 50 to 125 ft, and about 3.9 miles of 48-in. diameter pressure pipe with heads ranging from 50 to 100 ft; relocating 1,000 ft of sewer line, and numerous water, sewer, and communication lines within the city of Minot. The pipeline will have three railroad crossings and numerous road crossings. From 5 miles southeast of Minot to the Minot Water Treatment Plant. Sundre, Station 20+00 to Station 194+60, and Minot, Station 57+69 to Station 260+58.
Pick-Sloan Mo., Wyo.	Furnishing and testing programable master supervisory control equipment for the control of eight North Platte area powerplants from Caster Control Center. The master terminal is to be provided with color cathode ray tubes and will require limited graphic capability. (Additional technical details will not be available for discussion until the solicitation is issued.)

*Subject to change.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6893	Central Valley, West San Joaquin Div., Calif.	Dec. 9	Earthwork, pipelines and structures for Westlands Water District Distribution System, Laterals P29, P31, 31-1.5, 32, 36 and 37.	Granite Construction Co., Watsonville, Calif.	$4,091,939
DC-6896	Chief Joseph Dam, Chelan Div., Wash.	Nov. 12	Lake Chelan Pumping Plant, discharge line and regulating tank.	Bovee and Crail Construction Co., Paramount, Calif.	1,413,027
DC-6901	Pick-Sloan Missouri Basin Prog., Trans. Div., Mont.	Oct. 21	Construction of Terry Tap Substation, Shirley Tapline, and Shirley Tap, and modifications at Terry and Shirley Pumping Plants and switchyards.	Cochran Electric Co., Inc., Seattle, Wash.	222,712
DC-6904	Fryingpan-Arkansas, Colo	Nov. 29	Generator/Motor for Mount Elbert pumped-storage powerplant, Unit No. 1.	Westinghouse Electric Corp., Denver, Colo.	2,220,421
DC-6905	Columbia Basin, Wash	Oct. 18	Grand Coulee 500-kv switchyard, cable spreading yard, and transformer circuits, stage 01.	City Electric, Manson Construction & Engineering Co., and Osberg Construction Co., Seattle, Wash.	6,360,300
DC-6908	Pick-Sloan Missouri Basin Prog., Trans. Div., So. Dakota.	Nov. 1	Stage 08 additions to Sioux Falls Substation	United Power & Control Systems, Inc. Seattle, Wash.	285,859
DC-6909	Columbia Basin, Wash	Dec. 22	Installation of pump-turbines, reverse flow wheel-mounted gates and appurtenant equipment, electrical installations, and modifications of outlets to existing discharge lines for Units P/G7 and P/G8 for Grand Coulee Pumping-Generating Plant.	Scott-Buttner Corp., Oakland, Calif.	1,922,779
DC-6910	Teton Basin, Lower Teton Div., Idaho.	Dec. 13	Teton Dam and power and pumping plant	Morrison-Knudsen Co., Inc., and Peter Kiewit Sons' Co., Boise, Idaho.	39,476,142
DC-6911	Pick-Sloan Missouri Basin Prog., Trans. Div., Nebr.	Nov. 2	Stage 02 Additions to Grand Island Substation	Cochran Electric Co., Inc., Seattle, Wash.	306,432
DS-6912	Columbia Basin, Wash	Nov. 26	Armature windings for Generators at Grand Coulee Powerplants.	McGraw-Edison Co., National Electric Coil Div., Columbus, Ohio.	519,396
100C-1173	Chief Joseph Dam, Foster Creek Div., Wash.	Oct. 7	Replacement of pipe laterals	Washington Development Co., Seattle, Wash.	217,230
100C-1178	Columbia Basin, Wash	Oct. 29	D20-107 drain system, Block 20	John M. Keltch, Inc., Pasco, Wash	140,343
100C-1182	do	Nov. 22	D86-95 and D86-97 drain systems, Block 86	do	213,690
100C-1183	do	Nov. 12	Drains—Blocks 44 and 49	do	107,042
100C-1185	do	Dec. 10	D42-94, D42-97, D42-149, and D42-150 drain systems—Block 42.	Equipco Contractors, Inc., Ephrata, Wash.	129,943
200C-833	Central Valley, Delta Div., Calif.	Oct. 18	Installation of additional Pumping Units and related equipment in pumping plants No. 1, 2, 3, and 4, Contra Costa Canal.	M.G.M. Construction Co., Concord, Calif.	168,950
400C-488	Colorado River Storage, Ariz.	Dec. 16	Terrazzo and ceramic wall tile installation, Glen Canyon Dam and Powerplant.	Dryco, Inc., Downey, Calif	132,220
500C-302 (SF).	San Juan-Chama, N. Mex	Dec. 3	Exploratory drilling for ground water investigations.	Water Industries, Inc	139,700
604C-87	Pick-Sloan Missouri Basin Prog., Mont.	Dec. 3	Removal of gravel and rock fragments from Stilling Basin.	A. H. Powers, Inc., Seattle, Wash	156,240

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

May 197

RECLAMATION era

A WATER REVIEW QUARTERLY

May 1972 Vol. 58, No. 2

RECLAMATION era

Kathleen Wood Loveless, Editor

CONTENTS

COVER. Boating is only one of the fine sports enjoyed on the many Bureau of Reclamation reservoirs. Here, on Grand Lake, Colorado-Big Thompson project, sailboating is a favorite sport.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Reclamation's Recreation

With the multitude of labor-saving devices man has created to facilitate nearly every facet of life, he has more leisure time than ever before. The recent Congressional action moving national holidays to provide 3-day weekends and the proposed 4-day, 40-hour week, reflect the trend of the future.

It is no wonder our recreational areas are increasing in number and in visitor days per area to meet the demands of increased leisure time. Between 1958 and 1970 visitor days of recreation use at Bureau of Reclamation projects increased from 19.5 million to 55.2 million.

In the process of providing water users with vitally needed water for irrigation, industrial and municipal uses the Bureau of Reclamation has created 242 recreational spots most ideal for fishing, boating, water skiing, picnicking, sightseeing, and hunting.

Each recreational area has its own forte. For example, in the far Northwest, Banks Lake and the Potholes on the Columbia Basin project are notable for hunting and year-round trout fishing. In the more than 10 lakes on the project, there also is superior spinyray fishing. The Washington State Game Department stocks and manages these lakes. It reports the new lakes on the Columbia Basin project are among the best trout-producing lakes in Washington State.

This project also is one of the most popular areas for migratory waterfowl hunting and is becoming the major pheasant hunting area of the State.

Boating, water skiing, swimming, fishing, sightseeing and camping annually attract many outdoorsmen. Floating the Green River below the Bureau's Flaming Gorge Dam is a popular activity. The river is fed by the clear cold water from the dam and it teems with rainbow, brown, and native cutthroat trout.

As the recreation season approaches, we hope you will take advantage of the recreational benefits Bureau of Reclamation projects have to offer.

ELLIS L. ARMSTRONG
Commissioner of Reclamation

Utah's "Dead Sea" Is Still Alive

HALF a world and a mile of elevation lie between Palestine's Dead Sea and Utah's Great Salt Lake, yet there are striking similarities between the two.

Both are fed by a nearby fresh-water lake, and by a river named Jordan. Nature has denied each an outlet, resulting in an unusually heavy salt content in their waters.

Because each is a unique natural phenomenon, located near other attractions of both scenic and historic nature, tourists throng to these briny seas, drawn in great measure by the enthralling prospect of bobbing like corks atop water in which it is difficult—if not downright impossible—to sink.

Mineral salts abound in the waters of both and, because they are both known as "dead" seas, a store of legend and myth has grown up concerning them.

But there are also significant differences between the mountain-fringed lake in Utah and its desert-bound Middle Eastern cousin.

For one thing, Utah's "Dead Sea" is very much alive!

Short miles to the east, guarded by the towering ramparts of the snow-mantled Wasatch Mountain range, lies Utah's capital city, a thriving, modern metropolis which derives its name from the lake with which it shares a valley.

On the western shore of the lake, where the salt desert spreads its flat terrain toward Nevada, a $70 million plant is under construction to extract magnesium salts from the briny waters for use in manufacture of magnesium.

Sailboating on Great Salt Lake provides visitors a refreshing and relaxing activity. ***Photo courtesy Utah Travel Council***

Reclamation's Willard Bay

Midway along the east shore of the lake, Bureau of Reclamation engineers have erected a 14-mile dike to impound freshwater flowing down through mountain canyons to form the Willard fresh water bay which is providing new recreational possibilities as well as meeting irrigation needs.

And planners from government and private industry are mapping new blueprints to make Utah's inland sea a more viable part of the State's economy.

An air of mystery and legend has always surrounded the natural lake, largest in the United States west of the Mississippi. Long before mountain man Jim Bridger explored the lake in 1824, rumors of this body of water had mushroomed into fantastic stories that became part of early American folklore.

The largest remnant of a great fresh water lake which once covered the Salt Lake Valley and much of western Utah, the Great Salt Lake now is 75 miles in length, 50 miles wide and covers 1,500 square miles. Its waters are roughly 25 percent salt, nearly 8 times the saline content of ocean water.

Western explorers John C. Fremont and Jim Bridger explored much of this lake in a rubber boat in 1843, in the process laying to rest Bridger's original idea that he had "discovered an inland arm of the Pacific Ocean."

Cannot Sink

Since Brigham Young and some of the earl Mormon pioneers first swam in the lake in 184 discovering to their delight that one could floa freely on its waters without the slightest fear o sinking, the lake has become famous for swim ming. Many visitors to the Salt Lake Valley stil take advantage of the several south shore beache to bob buoyantly on its surface.

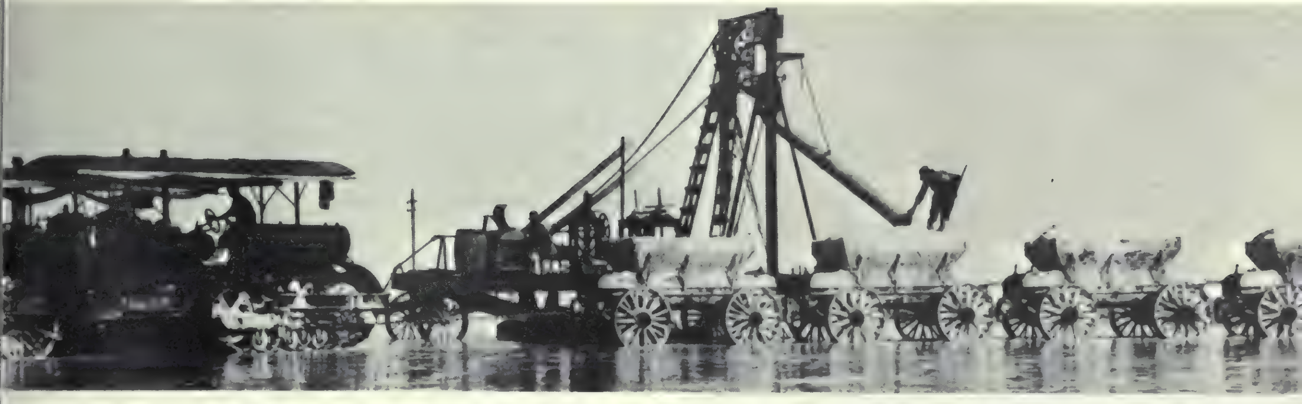
Despite this great natural attraction, howeve the fluctuating levels of the lake have made it dif ficult to establish permanent bathing facilities o the lake shores. Over the years, numerous such re sorts have been founded, enjoyed various period of prosperity, then faded when the recedin waters left the resorts high and dry. In a few rar instances, the resorts have even been flooded whe heavy precipitation caused an unusual rise in th water level.

The Great Saltair

Most famous of the Great Salt Lake resorts wa Saltair, built in 1893 when the lake was reason ably high and water splashed against the piling which supported the resort pavilions. In its hey dey, Saltair provided visitors a variety of enter tainment and its dance pavilion and roller coaste were famous throughout the Mountain West an much of the country.

From the turn of the century until 1930, wit

Even bathers of the early 1900's found sinking in the Lake nearly impossible. ***Photo courtesy of Utah Travel Council***



ne of Utah's earliest industries was extraction of salt from lake brine. Here salt is loaded onto old-time carriers. *Photo courtesy Utah Travel Council*

ne exception of a few years between 1900 and 910, reasonably high water levels kept the resort profitable operation. But between 1930 and 940, hard times fell upon the famed resort. Durg this decade, the lake dropped to its lowest corded levels and the water receded to several undred yards from the pavilion.

With the rise of the lake during the 1940's Saltr again enjoyed a brief resurgence as a resort, ut then the waters again receded and the onceroud resort fell into disuse. Repeated fires corched this grand "lady of the lake" and last ummer a violent blaze completely gutted the ructure. Despite efforts of private groups to save er, the majestic Saltair Pavilion never again will eign over the Great Salt Lake.

Particularly in recent years, as Utah came into er own as an industrial state, attracting new poplation and business ventures, plans have been roached and blueprints prepared to build new nd modern developments on the shore of the ke—mainly on the Salt Lake City end—but they roved to be more a dream than a reality.

Still, the lake continually stirs hopes of Utahans hat someday it may become a major recreation rea, although, considerable recreational opporunities exist now.

The high salt content of the water makes the ke unusable for such aquatic sports as water kiing, but winds which sweep out of the mountain anyons to the east and sometimes blow north or outh along the valley floor provide adequate reeze-power for a good many sailboats.

If and when plans for developing new beaches n Antelope Island, which lies in the lake northvest of Salt Lake City, are brought to fruition by either Government or private developers, boating may become far more popular.

A State park now exists on the northern tip of Antelope Island and a rough causeway supports a road which links the island to the valley land. But lack of funds has stymied efforts to build a modern, all-weather causeway, and violent storms which often whip the lake pose a constant threat and often wash away sections of the road and dike.

Proposed National Monument

Some State leaders and members of the State's Congressional delegation have proposed national

Hydroplane racing provides excitement for spectators at Willard Bay, Weber Basin project.

The *General James A. Garfield* (1921) proudly reigns over the salty Utah waters.

monument status for Antelope Island, complete with the development of bathing beaches and construction of dikes which would turn the southeastern portion of the lake into a fresh-water pond.

Man has already proved that such dikes are not only possible but feasible. Some 12 miles northwest of the city of Ogden, which is about 45 miles north of Salt Lake City, a 14½-mile earthfill structure, 36 feet in height, runs in a rough rectangle enclosing a bay of the lake which holds 215,000 acre-feet of fresh water when filled to capacity.

It is here that much of the water activity on the lake takes place. Sailboats dot the surface of Willard Bay on breezy days. Motorboats tow water skiers in graceful patterns and, at times, speedboats slice the bay's surface in well-attended boat race events.

In recent years, navigability of the lake has been a central question in legal disputes between the State of Utah and the Federal Government over ownership of the lake's shore lands.

At one time, boats of considerable size regularly plied commercial routes on the Great Salt Lake. In 1902, officials of the Southern Pacific Railroad embarked on an ambitious task. Engineers of the firm decided to build a causeway across a 40-mile section of the lake to shorten the rail route between the transportation hub of Ogden and the western shore of the lake. During construction of this famed "Lucin cutoff," barges loaded with construction materials regularly sailed the lake.

But long before this, a variety of vessels used the lake waterway for a number of purposes. In 1848, a group of Mormon pioneers used boats to conduct a major exploration of the entire lake. Boats became the principal method in the 1850's for ferrying livestock to and from ranching operations on Antelope Island.

The Lake's Vessels

Then, in 1871, the biggest vessel to use the Great Salt Lake hauled ore from the mines at the south end of the lake to a smelter located at Corinne on the northern shore. Named *City of Corinne* this vessel was a 240-ton, Mississippi River-type stern-wheeler. When the short-lived commercial venture failed, the *City of Corinne* was converted into a pleasure boat and for many years sailed the lake, making regular stops at various resorts.

One one such cruise, as the story goes, a noted visitor to Utah used a trip on the *City of Corinne* to indicate he might become a candidate for the Presidency of the United States. Whether the tale is true or not, the vessel was renamed in honor of the distinguished passenger and cruised the lake for years under the name of *General James A. Garfield*.

Not as majestic as the *General James A. Garfield*, but for children this "sea monster" is every bit as enjoyable. *Photo courtesy Utah Travel Council*

N.L. Industries, one of the world's largest producers of magnesium metal, is on the southwest shore of Great Salt Lake. *Photo courtesy N.L. Industries.*

Commercial ventures on or near the Great Salt ,ake have been many and varied over the years.)ne of Utah's earliest industries was extraction f salt from lake brine, and today at least three najor salt companies have operations on the south hore. It is estimated that the lake contains 8 billion tons of salt. But, in spite of the vast natural esources here, Utah produces only about 1 perent of the Nation's salt supply.

Potash has been produced near the lake for ears, but the industry really took hold in the 930's and is a significant contributor to the reion's economy.

Brightest hope for the future of the lake is its ast store of mineral salts.

'otential Industrial Site

Industries are looking to the lake as a source of nagnesium chloride, sodium sulphate, potassium hloride, and lithium chloride. In the eyes of nany, the lake is a mineral storehouse of untold otential which may yet prove of great and lasting conomic benefit.

One company which obviously believes this is V.L. Industries. It has under construction along he lake's west shore a $70 million plant to take nagnesium salts from the water for commercial nd industrial use.

An early industrial development dream involvng the lake is extraction of oil from the briny vaters.

Way back in 1861, an army battalion camped near Promontory, Utah—the spot where the ranscontinental railroad link was first estabished—found oil at Rozel Point.

This mystérious oil supply has puzzled geologists and frustrated every attempt to extract it from the lake. Some 32 holes have reportedly been sunk into the lake bottom in this area, in what is possibly the only off-shore oil drilling operation in water surrounded by an American desert.

Some estimates have it that 21 million barrels of crude oil lie beneath the lake. This oil is very thick, oozes to the surface occasionally in warm weather and often forms a gooey carpet of tar on the lake bottom. It is so thick that it is almost impossible to pump by ordinary means, but this has not discouraged efforts to tap the oil reserve.

Meanwhile, the lake remains a resource of obviously great value, its potential largely as yet unrealized, but waiting for the right circumstances to become an even greater asset. # # #

This young lady finds reading the newspaper easy while floating on Utah's salty lake.

LOST IN THE WILDERNESS

by C. R. (Bob) WHITMORE
Specifications and Procurement Branch
E&R Center, Denver, Colo.

WHEN I began teaching hunter safety for the Colorado Game, Fish, and Parks Department, I never dreamed that a few years later I'd be up there near the timberline—cold, hungry, and lost.

I especially never dreamed that I would have put myself there deliberately in 1971, with seven companions who must have been doubting their good sense, too.

We were in the Colorado Rockies, nearly 2 miles above sea level. The temperature was about 20 degrees, and around us the snow lay about a foot deep. Night was coming on, and with it subzero cold. We had no compass, no matches, no sleeping bags, no tents. We had only a few stale sandwiches and a candy bar or two among us. We had only the vaguest idea of our whereabouts.

The idea for this survival trip was mine. The Hunter Safety Coordinator for the Department suggested that I prepare a survival course for the State program for junior hunters. In our discussion, we discovered that for every hunter who is shot, the Game and Fish Department gets about 100 calls to help find a lost hunter.

Perish or Survive

So we set out to learn what it takes to survive in the mountains. Six of us spent 3 days and 2 nights on Mt. Evans in March 1969. Snowmobiles dropped us off in a blinding snowstorm. All we had to do was stay put and survive; the snowmobiles would return 3 days later to pick us up.

Our first job was to find shelter. With our hunting knives, we dug a snow cave in a snowbank large enough for all six of us to sleep on a mattress of pine boughs. It was 15 below zero outside that night. In our snow cave, it was 32 above.

The moderate exercise we did was fine, but it would not be adequate to simulate a man lost under actual conditions. We had no food, water, or cooking utensils. We had only a small survival kit with a few small tools. But the most important fact was we *knew* the snowmobiles would be back for us, and all we had to do was stay as comfortable as possible until then.

The other fellows on this exercise came from all walks of life. There was a plumber, a computer programmer, an airline pilot, and two teachers. Later, we analyzed what we had learned. After realizing we had learned little, I started thinking about another exercise that would more nearly simulate the conditions that would confront lost hunters.

The Second Trip

At a meeting of the Western States Hunter Safety Coordinators in Pinedale, Wyo., I was asked to prepare a survival manual for use by game and fish departments throughout this region. From that request I received authorization for a second exercise.

I was thinking of a solo outing, but too many people thought it was a good idea and wanted to go along. About 30 or 40 people asked to go, including some women who argued that women go on hunting trips and get lost, too. I had a tough time telling them "No."

Finally, I selected Harry Kissell and Jack Wilhite because they had made the first trip with

Above, seven of the team strike out across the snowy wastes on the first morning of their survival exercise. Below, Errol King flashes a smile of success as he pulls a native trout from an ice hole. Right, below-freezing temperature forced Jack Wilhite to warm his feet over a campfire during a break.

me. Harry is a Denver school teacher and also an instructor with "Outward Bound," an international school which teaches young people to survive under the most extreme conditions. Jack is an airline pilot and a lieutenant-colonel in the Colorado Air National Guard. Two men from the Wyoming Game and Fish Department enthusiastically volunteered to go—Dick Keeney, Director of Education, and Joe Vogler, Public Information Officer. Dale Gaskill, Director of Training for the National Rifle Association in Washington, D.C., also joined us.

We received two late additions when the news media heard about our plans. The Associated Press sent along Hunter Holloway, and United Press International sent Errol King. The ages ranged from King, the youngest at 30, to me, at 44.

Didn't Know Where We Were

We had only two meetings before starting the trip. Jack Wilhite arranged for an Army helicopter from the Medical Evacuation Service to drop us off in the mountains. The rules were pretty strict. The helicopter pilot wouldn't tell anyone where he would put us down. And we didn't find out. All we knew was we were somewhere north of Rocky Mountain National Park, in the north-central Colorado Rockies. We went dressed only as the average hunter might be, with warm clothing, a hunting knife, a sidearm, and perhaps a sandwich in our pocket. Nothing more.

We arranged with the Colorado Game, Fish, and Parks Department to send up a search airplane 24 hours after the start of the exercise to look for us. The pilot would be told only in the most general terms where we were believed to be. If he spotted us, he would drop a package containing some survival gear.

Our only real concern was the weather. If a good snowstorm moved in, or if someone got sick or was injured, we would stick with our plans. These are the hazards that might occur in an actual emergency, so we were determined not to make it easy on ourselves.

The chopper made four round-trips to bring in our group of 8, leaving us at the 11,000-foot level near a frozen lake. We hadn't seen any roads, buildings, or other signs of habitation during the approach to our landing site. So when the beat of the helicopter vanished, and we took stock of our surroundings, we knew we were really lost.

The last pair of men in our group hadn't landed until nearly dark, so we remained at the frozen lake the first night. We spent that night trying to get some sleep, but without much success. The chill factor put the temperature well below zero; one of the men huddled so near the fire he burned his parka.

A Meal of Pine Squirrel

There was little for breakfast. A couple of our group managed to shoot a magpie and a pine squirrel, which we dressed and roasted. There wasn't much to eat. Each man got about one pinch of meat, and the taste was pretty bad.

We heard the sound of an airplane about mid-morning and signalled it with a mirror. It was the Game and Fish plane. After spotting us it swooped low, and dropped the survival package on the nearby frozen lake.

Most of the package contents were smashed: compasses, pen lights, liquid fuel for the little camp stove we had hoped to use, and even some "tropical chocolate" bars which were so brittle from the cold they shattered into thousands of tiny slivers.

It was quite a disappointment, but we salvaged as much as we could, including drinking cups, snare wire, wire saws, 2-ounce survival blankets (a foil-like material that reflects body heat), metal matches, and steel wool. A metal match is a nail-size device which produces a spark. Steel wool, lit by a spark from a metal match, started our fires.

We headed in a northerly direction, following the drainage downslope toward what we hoped would take us to the Cache la Poudre River, which heads up near the Continental Divide and flows eastward. Our progress wasn't encouraging. We tried to set a steady pace, but the terrain was very tough and we were unsuccessful.

The Danger of Hypothermia

We didn't have much humor or desire for conversation after the first day. We perspired tremendously from exertion and the altitude, and we consumed enormous amounts of water to avoid dehydration—one of the great perils that confront someone lost in the mountains. It is important to *avoid* eating snow. It provides very little water, yet gives the psychological impression of having

quenched one's thirst. Consequently, a person can become dehydrated and get hypothermia without being aware of it.

Hypothermia is a condition in which the internal body temperature is lowered and the victim becomes clumsy, thick of speech, and sort of euphoric (an often unaccountable feeling of well-being or elation). It can kill so quickly that it is frightening.

We shot another pine squirrel on the second day, and supplemented it by eating a few juniper berries, the inner bark of the aspen tree, and some parasitic moss. None of which was very appetizing, but it was better than the batch of sage tea we brewed.

The third day, we stopped at frozen beaver ponds and chopped a hole through the ice. It was about 8 inches thick. Using a hook and a piece of foil, one of the fellows managed to catch a native trout. We used part of the entrails as bait to catch three others. None was more than 12 inches long, but they tasted fine.

Tremendous Exertion

Some of us were getting in rough shape by the third day. The exertion of moving through heavy downed timber or up and down steep, rocky slopes is unbelievable. Two of us had fallen and picked up some painful bruises. Another cut his hand, and one of the reporters had a 2-inch scalp cut inflicted by a broken branch.

Snow wasn't a problem; there hadn't been a major storm for some time, and generally it was no more than a foot deep. But toward the latter part of the exercise, hunger and exhaustion made us irritable.

On what proved to be the last (third) night out, I had the team split up to prepare individual shelters over a widely separated area. I wanted them to feel completely alone. Previously, we had paired off in our sleeping lean-tos, sleeping at a single campsite and using a common fire.

Each morning, we dismantled our shelters and discarded the branches over a wide area. We took pains to leave absolutely no trace of our passing. The absence of all signs of human trespass, incidentally, was one of the real pleasures of our journey. It was a totally clean and natural environment—beautiful.

We had been hiking down a very steep incline for about an hour on the fourth morning when we heard the sound of vehicles in the distance. The reaction? It was one of elation, pure and simple.

The Lost Aren't Lost

We reached a frozen river that some of us recognized as the Cache la Poudre, and just beyond was the highway. As we came packing out of the thicket, a motorist caught sight of us, rolled down his window, and called: "Are you guys *lost?*"

"Not any more!" one of our group responded.

We had walked only about 10 miles, taking 4 days to cover that distance, but it was some of the most rugged country imaginable. I believe it would have been impossible to follow our route in reverse: the path *up* would be incredibly steep and hazardous.

What did we learn? A great deal.

We learned, first, the average man can endure more than he thinks when he's lost in the wilderness. Second, we gained a new appreciation of the need to remain calm and to avoid panic. Third, the value of water became vitally important: it's easy to dehydrate in a remarkably short time. Food is less important than one might think. Eight of us survived for 4 days and 3 nights on 4 trout, 2 pine squirrels, and a magpie, and I lost only 8 pounds. (My normal weight is 210.)

Fourth, anyone lost during harsh weather should make a special effort, particularly at night, to get out of the elements. It's important to get under cover, whether it be a lean-to, a rock crevice, or a snow cave, to escape the wind, rain, or snow, and to conserve as much body heat as possible.

Finally, anyone going into unfamiliar territory should take along some basic equipment such as a signal mirror, matches in a waterproof container, a plastic whistle, and something in which to melt snow, for example, no matter how briefly he expects to be gone.

Why a plastic whistle? It's far superior to a gun for signalling, and plastic won't freeze to your lips as metal will in extreme cold.

Most importantly, perhaps, is the fact that hunters and hikers should always leave word with a friend or neighbor apprising where they are going and when they expect to return. There are legitimate reasons for getting lost. There are no excuses for staying lost. There is no need to die in the wilderness. # # #

RECREATION AT ANGOSTURA

ANGOSTURA Reservoir, in southwestern South Dakota near the southern part of the ;lack Hills, has proved to be an excellent water ecreation area since its formation. It was created ,pon completion of Angostura Dam in 1950 by the ;ureau of Reclamation. The dam is on the ;heyenne River near Hot Springs, S. Dak.

;ecreation at Angostura

Even though conservation space in the reservoir ; used primarily for storage of irrigation water, ecreational activities, such as boating, fishing, ;ater skiing, camping, and swimming, have been ;reatly enhanced.

A water surface of 4,700 acres and the surround-ıg 4,546 acres are available for recreation. Rec-eational use in 1970 totaled 100,000 visitor days. ıbout 70 percent of the recreation visits consisted f people residing within approximately 1-hour riving time over hard-surfaced roads. Most of the emainder were out-of-state vacationists, includ-ıg campers coming to the Black Hills area.

Shortly after the first impoundment of water ı 1949, the South Dakota Department of Game, ;ish and Parks eradicated trash fish species (carp nd suckers) from the reservoir preparatory to ;ocking it in 1950 with desirable species such as pike, bass, bluegill, and perch. The reservoir area was reopened to fishing on July 1, 1952. Fishing has been "good" to "excellent" except for two years during which there was substantial drawdown of reservoir water because of low inflows. The State Department of Game, Fish and Parks is continuing its fisheries management of the reservoir.

Recreational development and management have been carried out pursuant to plans developed by the National Park Service, the South Dakota Department of Game, Fish and Parks, and the Bureau of Reclamation.

A Memorandum of Understanding between the Bureau and the South Dakota Department of Game, Fish and Parks became effective on January 1, 1959, and provided for State administration and development of the reservoir for wildlife and recreation purposes. Prior to then, and since the reservoir became operational, the Bureau arranged for 8 wildlife habitat development areas and then so-called "minimum basic facilities" to accommodate immediate recreation needs.

The State has demonstrated recreational management capability although inadequate funds during the early years caused some delays. The availability of cost-sharing moneys under the Land and Water Conservation Fund Act of 1965 (administered by the Bureau of Outdoor Recreation)

has financed facilities, including access roads. Further improvements are planned and will be provided as additional funds become available.

Leased for Grazing

The reservoir was not surveyed until 1963 and administration of the lands was not easily managed prior to field identification of the property lines. Most lands without recreation facilities were leased for grazing. The Bureau is cooperating with the State in the installation of a fence on the boundary. This facilitates the management of the reservoir lands, including the control of livestock grazing. The State has long-range plans for curtailment of grazing and subsequent utilization of most of the land area within the reservoir boundary for recreation and wildlife use and development. Control of grazing has contributed to restoration of desirable vegetative growth on much of the reservoir area lands and thus has decreased the vulnerability of the soils to wind and water erosion.

A critical factor in management of the reservoir area for public recreation is the cost of providing all of the camp and area maintenance or policing forces needed to serve visitors. Where user fees are

nsufficient to cover a major share of these expen-ive services, a source of cost-sharing funds is ıeeded. The South Dakota Department of Game, ʻish, and Parks is confronted with this need in he management of Angostura, as are other gencies elsewhere.

The State plans to institute entrance and camp-round fees in 1972. Charges will be consistent vith areas that have similar facilities. The ex-ected annual recreation visitations to Angostura Reservoir are estimated to be 150,000 by 1975, over 00,000 by 1980, and should approach 300,000 by 985, if adequate facilities are available. # # #

Facilities for fishing, camping, boating and picnicking are plentiful at Angostura. *Photos courtesy South Dakota Department of Game, Fish and Parks*

WATER Quiz

1 Water comprises what percentage of the human body?
   a. 96
   b. 79
   c. 89

2 Pure water contains:
   a. hydrogen and oxygen plus 33 different forms of hydrogen and oxygen
   b. hydrogen and oxygen only
   c. 75% hydrogen and 25% oxygen

3 The Bureau of Reclamation now has recreation areas on _____ projects.
   a. 115
   b. 297
   c. 242

4 A *khanat* is:
   a. a method of water management
   b. another name for subsurface drainage
   c. a subterranean shaft which intercepts the water table underground

5 Boating is a common form of recreation on nearly all Bureau projects. One of the most unusual forms of boating is kayaking. In the conservancy district of which Bureau project are kayak races held annually, attracting competitors from all over the world?
   a. Colorado-Big Thompson
   b. Fryingpan-Arkansas
   c. Buffalo Rapids

Answers On Inside Back Cover.

Drip Drip Drip

by JOSEPH B. MARCOTTE, Jr., Chief of Water and Land Operations Division, Fryingpan-Arkansas project (former Repayment Specialist, Sacramento Valley.)

THERE'S a leak in the irrigation system on the Vint Symons, Jr. farm in the Red Bank area west of Red Bluff, Calif. In fact, there are several "leaks," but no one seems excited because it was planned. The "leaks" are through specially constructed devices called drippers and the purpose is for irrigation.

What's happening? It's called "drip" or "trickle" irrigation.

In keeping with the American tradition, the Tehama County Farm Advisor's office, in cooperation with Mr. Symons, is seeking a better way to "do its thing." While drip irrigation is fairly new to American agriculture, it is not new to the world. It was developed in Israel* and has been used extensively in some other countries.

The process is simple. Under normal irrigation practices such as flood, row, or sprinkler irrigation, water is applied periodically when the farmer decides it is necessary to meet the needs of his plants. Under drip irrigation, water is applied continuously, ideally at a rate which neither starves nor drowns the plant.

Experience has shown that drip irrigation can offer numerous benefits and in some cases permits irrigation where no other way is practical. Water can be used for production of crops only, rather than lost to weeds or non-crop areas. Water normally considered too saline for irrigation can sometimes be used. Weed control and irrigation labor costs are lowered. Plant stresses caused by too much or too little water are drastically reduced.

Conventional methods of irrigation depend upon periodic replacement of the available water supply in the soil. Unless extreme caution is used in the process, irrigators may apply too much water at the time of irrigation and then as the plant uses water, the root zone may become too dry before more water is applied. Both conditions impose a shock upon the plant's system, keeping

*See November 1970 issue of *Reclamation Era* pages 15–16 for additional information concerning the development of drip irrigation in Israel.

Artist's concept of drip irrigation on young walnut trees.

the plant from performing at peak efficiency throughout the growing season.

Once a drip system is properly regulated, plants never suffer from too much or too little water. By adding water-soluable fertilizers, water and plant food are always available in the quantities needed for optimum production. Dramatic increases in crop yield have been recorded when drip irrigation is used compared to other methods.

One additional benefit is the amount of water saved. When using conventional irrigation, it is practically impossible to apply exactly the right amount of water needed for plant growth. In attempts to apply exactly the amount of water needed for plant growth, irrigators often apply more water than the soil can absorb or retain, resulting in losses through deep percolation and surface runoff. By applying water in quantities only sufficient to meet plant needs, deep percolation and surface runoff are eliminated, resulting in significant savings.

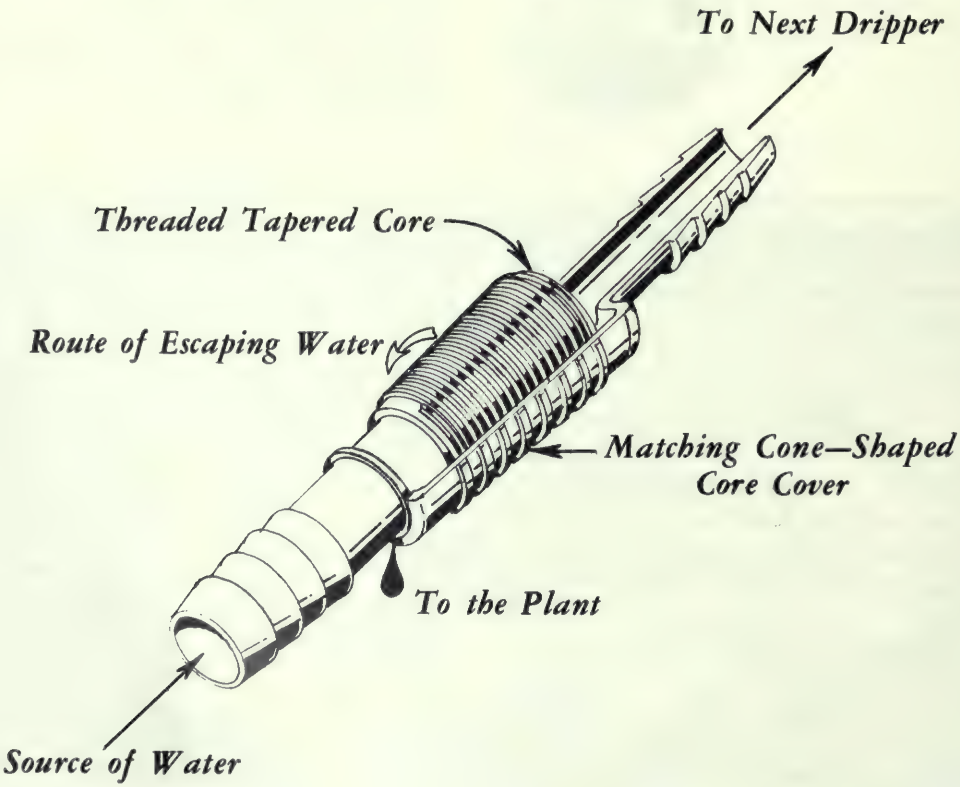
Many areas of the Sacramento Valley have a soil known as Tehama Loam, a very tight silt-clay mixture. Mr. Symons has planted a grove of walnuts on this type of soil. Tehama Loam presents almost insurmountable problems for irrigators. The infiltration rate is very slow, making it almost impossible to get good penetration of water applied conventionally at the surface.

The Farm Advisor's office and Mr. Symons hope to demonstrate that, with drip irrigation, water can be applied at less than the infiltration rate and in sufficient quantities to sustain the plant in a state of optimum water availability.

The demonstration plot consists of 22 walnut trees in their third year after grafting. Water is supplied from wells. The distribution system is made up of ½-inch polyethylene tubing with three drippers (technically known as emitters) at each tree. As the trees grow larger, they will require more drippers to a planned six per tree. Drippers vary in size and design as well as price, which ranges from 20 cents to more than $1.

The polyethylene drippers being used are of an extremely simple design consisting of a threaded tapered core covered by a matching truncated core. Water escapes from the system along the threads of the core which control the release rate by the friction along the thread itself. Total costs of installed drip irrigation systems range from $300 to $700 per acre.

While some drip irrigation systems operate at



This cross section illustrates the dripper (emitter).

pressures as high as 20 pounds per square inch, the operating pressure on this system is approximately 5 pounds per square inch. In regulating the system, it was discovered, however, that over-irrigation is possible with the drip system—two trees were drowned.

The system has been in use for only one season and is installed on top of the ground. The total weed growth has been reduced, although in the vicinity of the drippers, weed growth is prolific. With the system installed on top of the ground, the normal practice of mowing the weeds would also destroy the system. Caution is necessary in the use of herbicides, since they may damage the plastic pipe and drippers.

Burying the entire system was considered. This should facilitate cultural maintenance of the orchard. However, a number of problems cropped up. Since the infiltration rate of the soil is extremely slow, a large interface of water to soil must be provided; caution must be exercised to prevent roots from entering the dripper; and there is a risk of crushing the dripper with tractor-type equipment during cultural operations.

Experiments were conducted to determine configuration of the burial of the dripper. The best method found to date is to bury the dripper in a gravel-filled hole of adequate depth. An underlying clay stratum in the demonstration area causes the infiltration rate to be so slow that a practical hole size could not be found.

Due to the unresolved problem with weeds, the Farm Advisor is considering relocation of the experiment. A new site will be selected in the Tehama Loam type soil, but without the clay "barrier" so near the surface, making burial a possibility. The present thinking is to locate on olive trees, possibly in the Corning Water District.

After one irrigation season, trees irrigated with the drip system appear to have fared as well as adjacent trees irrigated with sprinklers. Although some problems remain to be solved, agriculturists are optimistic about the future of "drip" irrigation in Tehama County.

Should the drip system prove to be a viable means of irrigating high-value crops on tight soils, a dramatic solution to an old and serious problem will have been found.

# # #

Drip system components. Note size compared to walnuts.

THE THIRD POWERPLANT
. . .Its Impact on People

y SAMUEL S. REY, Administrative Officer
Third Powerplant Construction Office

Looking southwest from the dam, one can see Grand Coulee and Electric City.

THE Grand Coulee Dam area grew out of construction activities funded by a total Fed-ral investment of $761 million which began in 933. By 1951 Federal investment resulted in the ompletion of Grand Coulee Dam, two power-lants, a pumping plant, and the initial water istribution system. The distribution system with ix more units in the pumping plant, will even-ually supply the 1,000,000+ acreage potential of he Columbia Basin project.

he Community

Over this period of time, thousands of people vere employed. But after what was believed to be nal construction, the area settled down for a num-er of years into a comparatively calm urban ommunity.

The "community" was a loosely grouped, but ighly independent cluster of people. It consisted f four cities: Coulee Dam, established at the foot f the dam in about 1934 when construction first tarted; Grand Coulee, above the dam just up-tream from the left abutment; Electric City, to he west and now on the shore of Banks Lake; and Elmer City, 6 miles downstream from the dam.

Little did the residents realize they were des-ined again to experience not only the rumble and xcitement of heavy construction, but also dozens of major problems that would accompany the Third Powerplant program.

ncreased Power Capacity

It would have been difficult to realize then that his unprecedented construction effort would greatly increase existing power capacity. Expan-ion of the power facilities became possible through an international water treaty ratified by the United States in 1961, by Canada in 1963, and inally effected in 1964.

The Third Powerplant program, authorized by Congress in 1966, together with up-rating of existing generating units, will increase existing power capacity from 1,974 megawatts (mw) to 5,880 mw with initial installation of six 600-mw units. The Grand Coulee power complex may ultimately be increased to 9,780 mw by expanding the plant by installation of an additional 6 units, yet to be authorized, and installation of 6 reversible pump-generating units. Culminating in the 1990's as the world's largest power-producing complex, this program will entail over $400 million for the first 6 units and will be keynoted by hydropower generating units never before developed at a capacity of 600 mw.

The impact of these developments began to take focus in a preliminary task force report issued by the Bureau of Reclamation in July 1966. The report identified such problem areas as community relations, beautification and community planning, visitor programs, highway coordination, air transportation, housing and land acquisition, and coordination of construction activities with existing power operations.

The Impact

As the magnitude of the project became more apparent, the local people began to realize that the real impact they would experience would be "program-caused" but "people-related." "People-related" impacts include the space people occupy, the payroll dollars they earn and spend, the business and community services they demand, and

the apprehension concerning the effect this construction was to have on their social and economic base and structure.

One unusual aspect of the Third Powerplant program, in addition to its mind-staggering size and complexity, came through loud and clear—*the project would be built in and around the very heart of settled communities.* This would be quite different from the well-planned communities which the Government constructs when it builds in isolated locations.

One of the first "program-related" matters affecting the Grand Coulee Dam area was a determination in 1967 by the Bureau of Reclamation. This determination dealt with the amount and location of land needed to construct not only the authorized 6-unit plant, but also sufficient land to accommodate the long-range 12-unit program to avoid disrupting again the commercial and residential areas of the city of Coulee Dam.

This was a period of apprehension. Acquiring the needed land seemed impossible when it was realized that about 25 percent of the city of Coulee Dam would be converted to the Third Powerplant facility. This meant 54 residences, 8 businesses, the Government-owned visitors center and some city-owned community facilities would have to be purchased, relocated, or destroyed.

Relocation Was Successful

Through meetings and finally by professional appraisal and negotiation, the necessary properties were acquired in less than 12 months. A satisfactory arrangement which permitted reduced purchase prices provided for relocation of homes and buildings. All but one residence was relocated—mostly to other city lots in Coulee Dam.

A theater and bowling alley were provided, along with restaurant facilities and a fire hall in a new city-owned complex (six of eight of the commercial properties opted for salvage). Extensive public relations efforts began during 1967 to show hundreds of interested people, potential investors, suppliers, service groups, chambers of commerce, etc., the impact this construction had and is now having.

One comparison used involved employment at the recently completed Glen Canyon Dam. Employment was about 2,400 in 1971 and 1972, with peak annual payrolls exceeding $30 million. This contrasts with pre-Third Powerplant Bureau operation and maintenance payrolls of about $2,300,000 annually.

Above, the "bust" that followed the "boom" came in the form of many abandoned and deteriorating buildings which are now being cleaned up. Below, the old city-owned bowling alley in Coulee Dam is being razed to provide working area for contractor operations.

Problems of More People

But the local area also began to feel the "people-related" impact when the Third Powerplant staff began transferring to the city—all looking for a place to live.

Reminiscent of earlier construction days, business areas became crowded, traffic caused consternation among the "natives," and an unoccupied place to live was a rare commodity indeed! And what everyone really wanted to know was, "How many people will be here during the various stages of construction." Earlier task force studies were

ed. These showed future programs and through detailed study of the types and magnitude of nstruction to be involved, updated employment ıta were revealed.

These projected employment levels proved genally to be accurate. As a relative measurement, tal program accomplishment through fiscal year 71 amounted to about $141 million (or about e-third complete). A balance of about $292 milon remains within the authorized 6-unit program tending to nearly 1980 (the first three units are go "on the line" in 1974 and 1975; the second ree, originally scheduled for 1979 and 1980, are ing expedited).

ove, a familiar sight in Coulee Dam was the 49 homes en route their new locations. Below, with a mighty crash, the "headache-ll" struck the Bureau's tour center to make way for the Third Powerplant construction activities.

Prices Increase

One byproduct of the "people-related" impact, in response to the ever-growing local demand, was the rapid inflation of prices in real properties, as well as in goods and services. Many retired people who had found satisfaction in the quiet pre-Third Powerplant communities, the comparatively mild, dry climate, and the pleasure of the uncrowded north central Washington outdoor recreation, did not want to cope with the new hustle and bustle.

Many took advantage of the gain in property values, sold their homes to incoming workers, and relocated. Other extensive effort was made, however, to provide living accommodations, and during the first 4½ years, residential property growth was significant. There were no rentals except of older and inadequate buildings. New privately owned homes were individually constructed, as shown in the following table:

	Elmer City	Coulee Dam	Grand Coulee	Electric City
Homes relocated from "take-area"	5	43	—	1
New homes constructed	6	52	9	66

Even this growth was inadequate and several investors soon moved in to fill the gap. Spaces were developed for mobile homes and trailers to accommodate the vast majority of Third Powerplant workers. The result was an increase from about 340 spaces in 1968 to 1,207 in 1971 (a growth of nearly 400 percent), with proposed developments for additions expected to provide 1,500 spaces during peak construction years. Many trailer spaces and mobile home lots were established on private lots, but developments were principally in consolidated courts scattered throughout the area.

Another benefit was the razing of old tumble-down structures unoccupied since the boom days of Grand Coulee Dam construction.

Environmental Improvements

Such cleanup throughout the area has provided many good sites for new homes and has achieved some real down-to-earth environmental improvement. Solving the main housing requirement by providing trailer space dovetailed with the living habits of a majority of incoming construction workers. Many are skilled craftsmen and artisans

who move their families and trailers to distant areas as demanded by heavy industrial construction programs. Subsequent studies of the work force during 1970 supported this fact and further revealed that the construction work force, while extremely mobile, lives as close as possible to the jobsite.

About 20 percent of the work force was "local," living in or near the Grand Coulee Dam area prior to Third Powerplant construction. The remaining 80 percent moved in with the job. Moreover, of those who were not "local," 74 percent resided in the Grand Coulee Dam area while 26 percent commuted in, generally from within 50 miles. Thus, outlying communities within this radius experienced some measure of "people-related" impact, but to a much lesser degree and with almost none of the social and economic problems of the immediate Grand Coulee Dam area.

The Third Powerplant construction staff is comprised largely of college-trained professionals, and technical and business management employees who administer the program and provide technical review, supervision and surveillance of the hundreds of facets involved in this complex and fast-moving activity.

While stopgap trailer-type housing was leased by the Bureau to accommodate the staff and as an inducement in recruitment, this type of housing has basically become absorbed into the permanent community with 70 percent owning their homes and 30 percent renting private or Government-leased trailers.

Also benefitting the community is a large number of "Bureau-wives" who are active in nursing, teaching, and business. This settling-in process is in direct response to the dynamic impact of the Third Powerplant program.

While many workers will eventually go to other jobs and most are already veterans of many previous relocations from projects throughout the West, a significant number anticipate concluding their Bureau careers on this project. The huge and complex Third Powerplant program required selection of the best Bureau talent available, and the communities benefit from this as these people become involved in community affairs as concerned citizens.

School Facilities

It seemed, as housing problems were being resolved, that the major impact worry was over. But as families moved in they brought school-aged children in such numbers that local school facilities and teacher availability were overtaxed. The two school districts involved faced imminent funding problems. The student growth experienced by these districts in grades 1–12 is tabulated below:

Date	Grand Coulee District	Coulee Dam District	Four other small districts within 30 miles of Grand Coulee Dam	Total
Sept. 1966	407	623	796	1, 826
Dec. 1967	495	712	929	2, 136
Sept. 1968	650	737	939	2, 326
Sept. 1969	590	736	945	2, 271
Sept. 1970	617	802	972	2, 391
May 1971	709	831	984	2, 524
Sept. 1971	[1] 1, 616		1, 026	2, 642

[1] Grand Coulee Dam District consolidated.

Desperately, the districts sought Federal and State funding for current operations and for expansion. As an interim measure, both districts acquired several portable classrooms on a lease-purchase basis. Federal funding under P.L. 815 for new facility construction, as well as P.L. 874 for operation and maintenance of school systems, was badly needed but not available. Nor was it possible under the laws authorizing Reclamation projects to provide direct funding or assistance through Third Powerplant appropriations.

Ultimately, it was incumbent on local taxpayers to provide special property tax levies to meet the ever-increasing education needs, although limited relief was eventually received under P.L. 874.

An Old Rivalry

In coping with these problems, it became apparent that an old sectional rivalry, carried over from early construction days still existed. The *Coulee Dam School District*, which encompassed the towns of Coulee Dam and Elmer City, lies downstream of the dam in remote corners of Okanogan and Douglas Counties. The *Grand Coulee School District*, upstream of the dam, was similarly situated in remote corners of Grant, Lincoln, and Douglas Counties.

The town of Coulee Dam was developed during construction of the dam as an "engineer's town" and to some extent as a contractor's camp. Over the years the town had become established as a Federally-owned town, a well-engineered and fully

Relocatable classrooms accommodate the influx of students. Ten of these structures which each seat 60 students are currently in use.

maintained community. In the late 1950's, Federal control was relinquished, the town was incorporated under State law and the residents acquired homes and community properties.

On the other hand, the towns of Grand Coulee and Electric City had early origins through a boom-town approach with little planning. The only resources were derived from the residents themselves. During the same period that Federal control of Coulee Dam was relinquished, some aid was acquired for community facilities associated with Federally owned land in and around the town of Grand Coulee.

Intercommunity rivalry was most broadly manifested as it became apparent that State and Federal financial aid would be made available only when the two school districts consolidated to achieve more effective and coordinated educational management and effort. Those in opposition apparently feared a loss of individual high school identity and that a consolidated high school would not be located in their community.

School District Consolidation

Largely through the efforts of citizen groups which included many "newcomers" (with an assist by the local press), a vote was taken on this closely contested issue. The decision was that a full consolidation would become effective for the 1971–72 school year. The extensive effort necessary to achieve this was highlighted by a professional study made through the University of Washington which fully endorsed the principle and execution of a school consolidation. It also broadly examined the potential for junior college level study that could expand and develop in the community.

The consolidated school district is now proceeding with plans and actions to construct a new high school facility. With good local support, it is again utilizing a citizens' committee for policy guidance and execution of various phases of the overall educational plans for the Grand Coulee Dam area. The preferred site for this facility, between Grand Coulee and Electric City, is centrally located in the area where 75 percent of the high school population resides.

The long-range program, integrally geared to the overall Third Powerplant program, recognizes peak impacts during 1972 and 1973 and realistically plans for maintenance of a school population that will never return to pre-Third Powerplant levels. The program particularly looks to the quality of education and the repeat impacts to be experienced during construction of the second 6-unit development of the Third Powerplant. "Program-caused" and "people-related" impacts were and are a very dynamic consideration in the local educational area.

The task force study made during early years of the construction program also brought a realization of the need to explore and plan for the social and environmental impacts directly and indirectly related to the long-range Third Powerplant program.

In 1968, the Spokane, Wash., firm of Kenneth Brooks, Architectural Consultant, completed a study of the area's industrial, social and economic conditions, capabilities, and potentials.

Environmental recommendations which were developed included a 10-stop visitors' grand-tour of power facilities and the immediate area; a new arrival center; a chain of lakes; portage canal and

wildlife refuge, all downstream of Grand Coulee Dam; an extensive lighting program; a campground and swimming pool to replace facilities at Elmer City; a jet airport; and a non-jet strip along Banks Lake, soon to begin construction under local Port District sponsorship; scenic and recreational improvements; highway and bridge improvements; and development of industries, schools, housing and towns.

An environmental advisory council including leadership from all levels of State and local business and government, was formed to consider Mr. Brooks' recommendations. These recommendations serve a variety of interests as a thought-provoking guide. They point out the potential greatness of the area and the environmental decisions that should be considered as growth and expansion continue.

Concurrently, an area-wide Conference of Governments was formed to provide coordinated planning and review in such areas as water and sewage, transportation, education, law enforcement, etc. Such an organization was required to assure even cursory consideration for Federal and State assistance in funding. As this organization developed, its scope of interest has greatly widened.

A local coordinated group is emerging to weigh and consider a multitude of common and related community and area plans and actions. This group will not only deal with "people-impacts" at its level, but will encourage the translation of these plans into reality. The infusion of change and new people into the Grand Coulee Dam area, and the dynamic functioning of citizens' groups and environmental and planning bodies is providing local direction needed to aid the community as it grows

Such efforts tend to be hidden in the shado of the huge Federal investment in the Gran Coulee area, particularly as total local tax re sources are limited by that very fact—i.e., there i taxation on private properties, businesses, an sales, but none on the Federal plant that sired an nourished these communities.

Impact on Business

On the other hand, local businesses have re ceived the impact of the Third Powerplant pro gram as a welcome gain over earlier business ac tivity. The growth (25 percent in establishment and 44 percent in employment) in this "support activity is shown in the following table:

Category	Commercial establishments		Nonbureau employment	
	1967	10/71	1967	10/71
Retail stores	44	39	144	18
Professional and personal service	11	25	31	6
Hotels-motels-trailer parks	12	21	21	4
Automotive and petroleum	19	28	56	7
Restaurants	12	14	64	9
Banks	2	2	12	1
Insurance agencies	7	4	12	[illegible]
Local contractors	15	7	29	3
Local and State governments	9	12	89	10
Lumber mill	1	1	44	4
School districts	2	1	97	14
Hospital	1	1	0	3
Miscellaneous	25	51	56	10
Total	167	206	655	94

This motel was constructed to replace an old one destroyed during the construction of the dam. Each of the modern 47-units has balcony view of Grand Coulee Dam.

ith a style which suggests kinship to Grand Goulee Dam, this concrete facility provides a fire hall, restaurant, bowling alley and theater for area residents.

Expansion and construction of business and ecreational facilities indicate the favorable reacon of local businessmen. It shows their desire to rovide the goods and services demanded by the people-impact." Also, local suppliers have effecvely serviced on-site contractors for many of ieir day-to-day supply requirements and spealty services.

During 1972 and 1973 as construction continues a the Third Powerplant and Forebay Dam, onte fabrication and installation of huge turbines nd generators will continue and additional conacts will be awarded for switchyard and powerlant completion. During the same period, two dditional pump-generators will be installed in ie Grand Coulee Pumping Plant.

With the authorized 6-unit program now about ne-third completed, peak employment is still to e achieved. Present employment levels of about ,500 in contractor's forces are expected to expand) about 2,100 with the increase residing in the Grand Coulee Dam area. While new "people-related" impact problems are not expected, the degree of impact will certainly be heightened beyond what the area has experienced to date.

Installation schedules being expedited on the second group of three power units will cause employment levels to remain higher than anticipated in the late 1970's. When authorized by Congress, the extension of the Third Powerplant and installation of six additional power units will make the 1980's a replay of the first decade for high construction employment and "people-related" impacts.

Other vital programs for recreational development and the possibility of a High Voltage Test and Research Center being established here are dynamic forces that will bring new impacts and an impetus to further weld the Grand Coulee Dam area into a cohesive structure. The experience gained over many years of growth and construction should well serve area residents as they live through the still exciting periods ahead. # # #

FIFTY YEARS AGO
in Our Magazine

RECLAMATION RECORD 1922

Minidoka Project, Idaho

THIS project, located in southern Idaho, is a good example of the substantial returns of irrigation development. In 1904 it was an uninhabited sage brush desert, no towns, no farms, no railroads, no facilities of any kind. All that it is to-day is the result of the construction of irrigation works by the United States Reclamation Service. The cost of reclaiming the present irrigated [irrigable] area of 121,000 acres has been $5,800,000. Of this amount $1,600,000 has been repaid.

The project includes several large undertakings outside the present irrigated area. The Jackson Lake Reservoir supplies water to 630,000 acres besides the land for which the Government has built the canals. The American Falls Reservoir, when completed, will furnish water to safeguard the crops on 900,000 acres that are now in cultivation and a complete water supply for 450,000 acres of new land most of which will probably be available for homestead entry.

A proposed extension adjoining the present irrigated area on the north and west contains 115,000 acres of public land. The net construction cost of the entire project has been $7,200,000, of which $2,600,000 has been repaid.

Milk River Project, Montana

PROJECT Manager Stratton . . . comments as follows on the reports of dryfarmed and irrigated crops . . . The lower crop value per acre as a whole on irrigated land as compared with that of dryland crops is due in large part to the fact that about 50 percent of the irrigated area is in native hay and only about 30 percent of the dry area is in that crop . . .

In regard to alfalfa, the price was so low tha some of the farmers did not cut their fields, o cut only once. This applies to a greater extent o the irrigated than on the dry lands . . . . Alfalf was also damaged to some extent by heavy rains i June just after having been irrigated. Or to put i another way, irrigation was a damage to alfalf crops in these cases.

In regard to barley, there were only 10 acres o the irrigated area and 14 acres on the dr farmed . . . .

For beans the records are for 1 acre irrigate and 3 acres dry farmed . . . .

In regard to wheat and flax the irrigation wa in some cases applied after the weather had be come hot, so that the grain was scalded . . . .

(Explanation of low production was:)

1. Lack of skill or care on the part of th irrigator.

2. June irrigation followed by heavy rain.

3. The best dry-land crop reports were thos that occurred on sandy loam in sheltered spo along the river; these crops tended to increase th average production on dry farms.

4. In nearly every case crops grown on dr farms were produced on ground that had been pr viously irrigated and cultivated, thereby gainin considerable advantage over quite a number of th irrigated wheat crops which were produced o first-year land.

today...

Minidoka Project 1972

THE Minidoka project now furnishes a full or supplemental water supply to more than 1 illion acres of land from 6 reservoirs having a ombined active storage capacity of 2,784,600 re-feet.

This water, stored and used and restored and used on land that was formerly a barren sage-rush flat, makes possible homes and a livelihood r thousands of people today.

The project works consist of the Minidoka Dam, eservoir, and hydroelectric powerplant; Jackson ake Dam and Reservoir; American Falls Dam d Reservoir; Island Park Dam and Reservoir; rassy Lake Dam and Reservoir; Palisades Dam, eservoir, and powerplant; 2 diversion dams; 293 iles of canals; 672 miles of laterals; 537 miles of ains; and 190 water supply wells.

Recreation on the Minidoka project has greatly creased since 1922. American Falls Reservoir and land Park Reservoir are popular for picnicking, imming, boating, and fishing, primarily for out. Lake Walcott provides picnicking, boating, d some fishing.

A spectacular setting immediately adjacent to rand Teton National Park and only a few miles uth of Yellowstone National Park attracts many cationers to Jackson Lake. Fishing, boating, imming, camping, hiking, riding, and other out-or sports are available in summer, and the area becoming widely known as a winter sports cen-r as well.

Milk River Project 1972

THE Milk River project, in northcentral Montana, has irrigation service available to about 21,000 acres of irrigable land of which 96,500 acres are irrigated. Project features are Sherburne Lake, the Nelson and the Fresno Storage Dams; the Dodson, Vandalia, St. Mary, and Swift Current Diversion Dams; the Dodson Pumping Plant, 199 miles of canals, 248 miles of laterals, and 185 miles of drains. A water supply is furnished to project lands which are divided into the Chinook, Malta, and Glasgow divisions and the Dodson Pumping Plant unit. The lands extend approximately 165 miles along the river from near Havre to a point 6 miles below Nashua. No power is developed on the project.

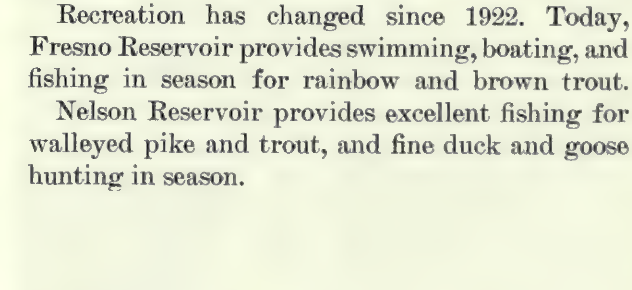
Irrigation on the Milk River project has increased greatly in recent years, as indicated by these figures beginning, in 1948:

Year	*Acres irrigated*
1948	72,000
1958	87,500
1968	97,200

Much of the grain irrigated is used to feed livestock with the remainder going to the market to be sold.

Recreation has changed since 1922. Today, Fresno Reservoir provides swimming, boating, and fishing in season for rainbow and brown trout.

Nelson Reservoir provides excellent fishing for walleyed pike and trout, and fine duck and goose hunting in season.



Recreation Land and Our Responsibility

by ROLAND V. SNOW, Recreation Resource Specialist, Washington, D.C.

Above, water's edge camping at Shadow Mountain Reservoir, Colo.-Big Thompson project is an enjoyable experience for the whole family. Right, youngsters enjoy the cool waters of Ruedi Reservoir on the Bureau's Fryingpan-Arkansas project. Below, a brisk wind from an approaching storm sends this sailboat speeding across the surface of Grand Lake, Colo.

WITH the increased leisure time many Amer icans are experiencing today, it is no wonde the pressures of increased usage of recreation area are constantly mounting.

The Bureau of Reclamation's recreational em pire now comprises 242 recreation areas. Thes include 199 storage reservoirs, 31 diversion reser voirs, and 12 non-reservoir areas. These areas con tain 3.7 million acres of land and 1.5 million acre of water available for recreational use by th public.

They do not include the other project area (mostly the irrigated land areas) that have sub stantial recreational values for such activities a hunting, fishing, and swimming, mostly by loca residents.

Pursuant to the Bureau's historical policy, most recreational management responsibility has been transferred under formal agreement to other Federal and non-Federal agencies, as shown in figure . Of the 242 Reclamation recreation areas, the Bureau manages 18. The states, primarily through park departments and fish and game departments, administer 96 areas. The Forest Service is next with a total of 44 reservoirs in or adjacent to national forests.

The remaining recreation areas are distributed primarily among counties, water user organizations, the Bureau of Sport Fisheries and Wildlife, and the National Park Service. Altogether 151, or 62 percent of the 242 areas are administered by non-Federal agencies.

Visitor Days Increase

The Bureau's policy of transferring recreational management responsibility to other agencies evolved many years ago when recreational use was at a much lower level than today, and when such use generated fewer demands and problems than we cope with today. As shown in figure 2, in terms of visitor days, recreational use increased from 6.6 million in 1950 to 54.2 million in 1970, or 721 percent.

Accompanying this seven-fold increase on Bureau projects has been the need to provide appropriate facilities and adequate management capability to supervise such use and to protect the physical, environmental, and recreational resources.

It is becoming more apparent, sometimes in dramatic fashion, that these requirements are not always being met. To a large extent, the challenges that are arising with increasing frequency involve inadequate facilities, limited management capability, and austere financing, particularly among the non-Federal managing agencies.

Without adequate financing, facilities cannot be provided to accommodate the increasing public use. In addition, some non-Federal agencies, particularly counties, have not developed management capabilities to cope with the increasing responsibilities. In some instances, managing agencies have been unable to resist pressures for exploitation of recreational values by commercial interests. When this happens, private profits are maximized, and the public interest is minimized.

Legislation has been enacted during recent years which authorizes the use of Federal funds at Reclamation's recreation areas. Most significant were the Land and Water Conservation Fund Act (P.L. 88–578) and the Federal Water Project Recreation Act (P.L. 89–72). Both were enacted in 1965, and both require Federal/non-Federal cost sharing.

In addition, some acts authorizing individual projects have included consideration of recreation in project plans—for example, the Colorado River Storage project and the Fryingpan-Arkansas project.

Neither the general nor the specific legislation, however, provides for Bureau financing needed to carry out its increasing responsibilities for administration of recreation, including adequate supervision of managing agencies. Nor does the legislation recognize the need for funds for Bureau development and management of problem areas where alternative solutions are not available. However, the lack of a positive Bureau program probably cannot be blamed entirely on the absence of specific legislative authority.

It is possible that the Bureau has not utilized all the authority now available under Reclamation law to meet its growing responsibilities in recreation. We are making an effort to fill some of the gaps. At the recent program conference in San Jose, a line item was added to our program to request nonreimbursable funds for recreation operation and maintenance.

This is an innovative step in the right direction which reflects the Bureau's positive response to a growing challenge. A firm and well-supported stand will now be needed to "backstop" this and other appropriate action at higher echelons.

Private Ownership

The need for positive action by the Bureau is not limited to past inadequacies in management expertise and funding. Privately owned recreational land throughout the Nation, including the Western States, is being sold at what sometimes seem to be exorbitant prices. Because of growing demand and the limited areas of such lands, these pressures are expected to increase. The land subdivision developers who sell recreational homesites actively exploit this interest.

Reclamation's Prime Land

The market that has been established in the recreation homesite subdivision business provides a basis for measuring the value of the Bureau's recreational resources, such as the lands within our

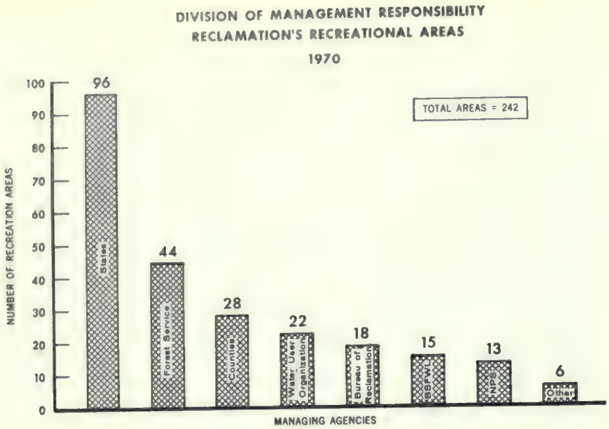


Figure 1

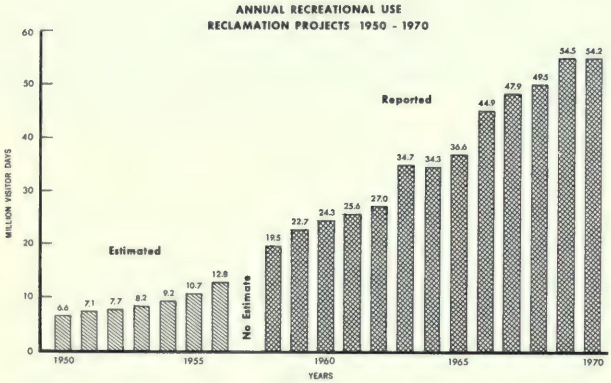


Figure 2

existing 242 recreational areas. Most of these lands would bring premium prices if available for sale, since they are waterfront property.

If we assume a price of $5,000 per acre, which could well represent a net price above selling cost, for the 3.7 million acres of land now available for public recreation use, we arrive at a market value of $18.5 billion. By comparison, the investment in all Reclamation facilities of every kind through fiscal year 1970 totaled $6 billion. As a minimum, the significance of these relationships should generate a healthy respect for the magnitude of our responsibilities in the management of our recreational resources.

Any lack of appreciation within the Bureau regarding the value of these recreational resources has not been duplicated in the business world. Profit potentials of many of our reservoir areas have been carefully assessed by land subdivision, mobile home, cabinsite, and other interests.

In at least one instance, a land subdivider nearly succeeded in blocking public access to provide his homesite purchasers exclusive use of the reservoir. He attempted this by acquiring lands surrounding the most valuable part of a reservoir. Such efforts usually become evident at those reservoirs where the recreational management capability is weak, and where little or no development of public recreational facilities has occurred.

A closely related matter involves the interests of some social or activity-oriented groups such as fraternal organizations and boat clubs, most of which have local political connections. The efforts of such groups to secure preferential rights to some of our recreational resources are often difficult to resist.

An effective and practicable response requires that any development by such interests be consistent with approved comprehensive plans and that public access to reservoir shorelines or land areas is not impaired.

Figure 3 provides some perspective on how intensively our recreation areas are used. Intensity was determined by computing, for calendar year

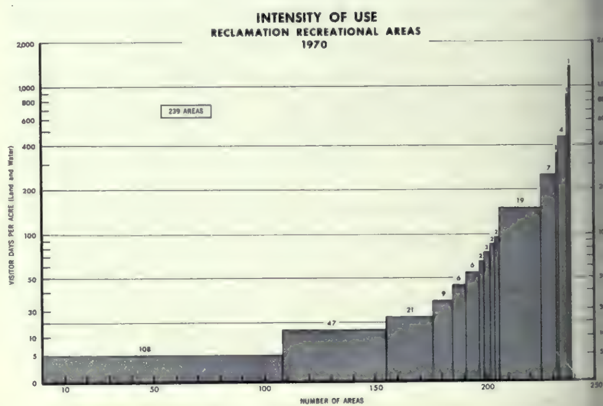


Figure 3

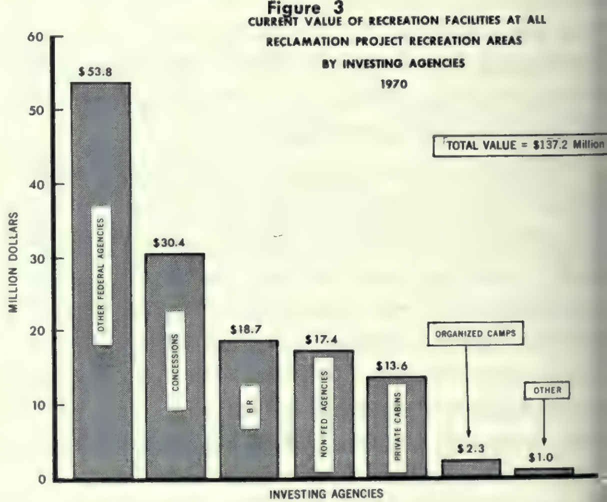


Figure 4

970, the number of visitor days per acre of land nd water available for recreation. The resulting ange extended from less than one visitor day per cre at such areas as Horseshoe Reservoir on the alt River project, Lake Powell on the Colorado iver Storage project, Kesterson Reservoir on the entral Valley project, Platoro Reservoir on the an Luis Valley project, Lake Walcott on the inidoka project, and Lake Bowdoin on the Milk iver project, to the astounding maximum of 1,373 sitor days per acre that occurred last year at East ortal Reservoir on the Colorado-Big Thompson roject.

Running a close second to East Portal Reservoir as Lake Estes with 877 visitor days per acre, also n the Colorado-Big Thompson project. The chart as prepared by grouping individual areas into ze groups according to average visitation per acre nd charted on a logarithmic scale to permit pres- ntation on a graph of reasonable size. The groups re charted at their midpoints.

Minimal Use Areas

The most significant fact portrayed by this chart the large number of areas with minimal use ntensity. For example, of the 239 areas chartered, 98 have average intensity of five visitor days per cre, an additional 47 with 15 visitor days per acre, nd 21 with an average of 25 visitor days per acre.

Where substantial development has been under- ken responsive to public use pressure, intensities f from 100 to 300 visitor days per acre are experi- nced. Included in this group are such as Cachuma ake in California, Pinewood Lake in Colorado, amestown Reservoir in North Dakota, Lake hunderbird in Oklahoma, Emigrant Reservoir in regon, Pactola Reservoir in South Dakota, East anyon Reservoir in Utah, and Conconully Reser- oir in Washington.

Most of our recreational areas are presently tilized at levels far below their potentials. This, oupled with the near certain prospect of increas- ng use pressures at all areas, further emphasizes ur responsibility for judicious development and anagement, in the public interest, of these valu- ble recreational resources.

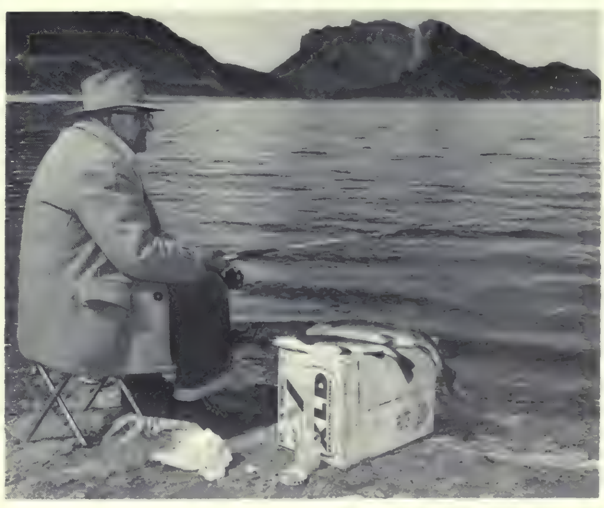
A reflection of the Bureau's limited investment n recreation is provided by the values of existing ecreational facilities broken down to show re- ponsible agency categories. Such values, in terms f "present worth" total $137.2 million as shown in figure 4 for calendar year 1970 for our 242 recreational areas.

The two largest investors are other Federal agencies and concessioners. Combined, they have invested $84.2 million, or 61 percent of the total. The Bureau is in third place with $18.7 million or 13.6 percent, followed by non-Federal agencies with $17.4 million or 12.7 percent. The investment of $13.6 million in private cabins is equal to over 70 percent of the Bureau's investment in public use facilities.

Our experience in recent years at areas managed by others than the Bureau indicates that inadequate management capability and the usurping of public use rights by special interests often occur where the Bureau has exercised too little administrative control or surveillance over the managing agency. Thus, it is quite clear that the Bureau's past policy is less than adequate for many of the recreational areas under management agreements with non-Federal agencies.

This is because insufficient consideration has not been given to the "party of the third part." This party is the public interest, which involves many ramifications not included in other contracts, but which the Bureau must protect, under existing policy and law. This, in my opinion, is our greatest responsibility for the recreational resources of Reclamation projects. A predictable consequence of our failure or indecision to meet this responsibility is the loss of options available to us through the inevitable transfer of our administrative duties into the political arena. # # #

This fisherman finds peace, quiet and fish aplenty along the shore of Flaming Gorge.



NEWS NOTES

Mt. Elbert Pumped-Storage Powerplant

The award for the Mt. Elbert Pumped-Storage Powerplant, a feature of the multipurpose Fryingpan-Arkansas project in Colorado, was made January 6, 1972. This plant will contain a 100,000-kilowatt reversible unit, with provision for addition of a second unit of equal size at a later date.

The contract went to Martin K. Eby Construction Co., Inc., and Equipment Rental and Sales Co., Inc. They will construct the Mt. Elbert Pumped-Storage Powerplant on the north shore of Twin Lakes, on Lake Creek, about 15 miles southwest of Leadville, Colo., some 9,200 feet above sea level. A forebay reservoir of about 10,000 acre-feet capacity will be built later on a hill above the powerplant.

Pumped storage has developed through an era of increasing concern over environmental protection. It is an efficient and reliable method of furnishing badly needed peaking power.

Bureau Aids Recycling Program

The Bureau of Reclamation has agreed to amend a water service contract with the Contra Costa County Water District in California to facilitate the district's participation in a major waste water recycling program.

This imaginative water recycling program supported by the Administration could be a model operation for the conservation of water resources in many of our arid and semiarid areas.

The program is designed to provide renovated water for further beneficial use, and the interception of sewage pollution will aid in improving water quality in the California Delta.

James R. Smith, Assistant Secretary—Water and Power Resources, said the water district has directed its efforts since enactment of the Water Quality Act of 1965 to development of a Water Resources management-Pollution Control concept.

The purpose is to conserve water resources in the Central Valley project and to avoid construction of water projects, when feasible, by intercepting and treating stream polluting domestic sewage and reclaiming it for industrial uses and open space irrigation.

Participants in the program include the Contra Costa County Water District, Central Contra Costa Sanitary District, California State Water Resources Control Board, and the Environmental Protection Agency.

The recycling program is expected initially to make 20,000 acre-feet of reclaimed water available annually, reducing by that amount the supply required by the Water District, at least in the early years of operation.

Commissioner Armstrong Elected Chairman

Commissioner Armstrong was elected chairman of the U.S. National Committee of the World Energy Conference for a 2-year term. Commissioner Armstrong served as vice-chairman—International Division of the National Committee during the past 2 years.

His elevation to the chairmanship was voted at El Paso, Tex., at a meeting of the U.S. National Committee. He succeeds F. Norman Woodruff, manager of gas proration operations, El Paso Natural Gas Co.

The U.S. National Committee has the objective of better serving national energy requirements and is also preparing for the Ninth World Energy Conference, which will be held in Detroit, Mich., in September 1974.

Record Reclamation Programs—1972 and 1973

The Congress has approved requests for supplemental appropriations for fiscal year 1972, totalling $16,610,000 for the Bureau of Reclamation. This means the Bureau now has a total approved 1972 program of $401,039,000, the first for any year to exceed $400 million.

But, this will not be a one-time occurrence. The appropriation request submitted to Congress for the fiscal year 1973 budget was $516,031,000, which greatly surpasses our 1972 record year. If this is approved by Congress, it will make possible acceleration of work on such projects as Central Valley, Fryingpan-Arkansas, Bonneville unit, Palmetto Bend, Garrison Diversion unit, and many others.

Arizona Projects Office in Phoenix

The Bureau of Reclamation is realigning its activities in central Arizona with the establishment of an Arizona Projects Office in Phoenix.

U.S. GOVERNMENT PRINTING OFFICE:1972 O—457-194

The new office will handle all preconstruction nd construction activities for the central Arizona roject as well as certain other Reclamation funcons to be assigned.

The Phoenix Development Office was deactiated and selected personnel from that office were ssigned to the Arizona Projects Office.

Key personnel include C. A. Pugh, projects anager; Richard E. Shunick, associate projects anager; O. H. Lillard, division of planning; obert W. Gilbert, former assistant to the reional director, region 4, headquartered in Salt ake City, Utah; A. K. Dolyniuk, former conruction engineer in the Parker-Davis Project ffice in Phoenix; and M. C. Thomas, formerly ffice engineer for the Southern Nevada Water roject, Henderson, Nev.

These men were carefully selected from the nks of Reclamation's career employees to form the nucleus of a highly trained engineering and administrative organization to handle the complex duties associated with the Bureau's huge water development program in Arizona.

Men Who Made Marks in 1971

On February 9, the Commissioner was honored at a dinner sponsored by *Engineering-News Record* magazine held in New York. He was named by *ENR* as one of several "Men Who Made Marks in 1971," for his work in pushing underground excavation technology including the proposed Stillwater Tunnel underground excavation research.

Answers to Water Quiz

1. c; 2. a, This was discovered by Dr. Harold Urey in 1934; 3. c; 4. c; 5. b.

MAJOR RECENT CONTRACT AWARDS

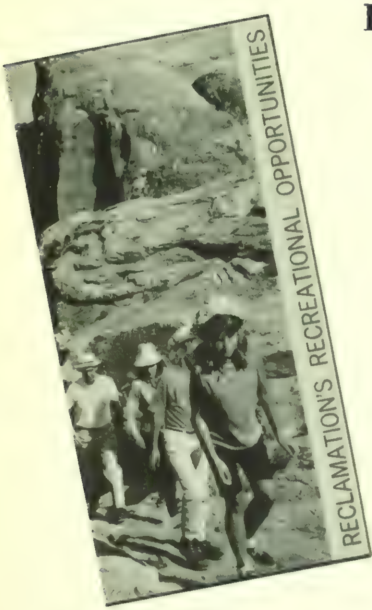
Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
S-6884	Central Valley, Calif	Feb. 8	Armature winding for generator unit 3, Shasta powerplant.	McGraw-Edison Co., National Electric Coil Division, Columbus, Ohio.	$224,464
C-6915	Fryingpan-Ark., Colo	Jan. 6	Mount Elbert pumped-storage powerplant	Martin K. Eby Construction Co., Inc. and Equipment Rental and Sales Co., Inc., d.b.a. Eby & Co., Wichita, Kans.	16,239,483
S-6917	Columbia Basin, Wash	Feb. 24	Primary unit substation for Grand Coulee 11.95-kilovolt switchyard.	United Power & Control Systems, Inc., Seattle, Wash.	359,259
C-6918	Colorado River Storage, Wyo.-Colo.	Jan. 12	Archer-Weld 230-kv transmission line, stage 1	Malcolm W. Larson Contracting Co., Inc., Colorado Springs, Colo.	1,407,895
C-6919	Navajo Indian Irrigation, N. Mex.	Jan. 17	Siphons, tunnel, concrete-lined canal and access roads, main canal, station 1067+00 to station 1105+60 and station 1398+75 to station 1732+00. Schedules No. 2 and 3.	Vinnell Corp., Alhambra, Calif	14,753,240
C-6920	Colorado River Storage, Colo.	Jan. 6	Crystal Dam diversion tunnels	Al Johnson Construction Co., Minneapolis, Minn.	1,578,965
S-6921	Middle Rio Grande, N. Mex.	Mar. 7	Aerial photography, rectified photographs, cross-section data, Rio Grande, miles 20 to 206 and topographic map compilation, Cochiti Dam and reservoir area. Negotiated.	Limbaugh Engineers, Inc., Albuquerque, N. Mex.	228,552
C-6925	Central Valley, Calif., San Luis Unit, West San Joaquin Div.	Mar. 2	Earthwork, pipelines and structures for Westlands Water District distribution system laterals 14, 15, 17, 19, 27, 33 and 34. Schedule No. 1.	Perini Corp., San Francisco, Calif.	10,049,400
C-6926	Central Valley, Calif	Feb. 7	Earthwork, concrete lining and structures, Tehama-Colusa canal reach 1, station 682+00 to station 733+00.	Gordon H. Ball, Inc., Danville, Calif.	1,804,790
0C-1187	Columbia Basin, Wash	Jan. 14	Drains—block 85	John M. Keltch, Inc., Pasco, Wash.	347,374
0C-1188	do	Jan. 3	D78-102, D78-106, D78-106-2, and D78-107 drain systems and D78-101 drain extensions, block 78.	Equipco Contractors, Inc., Ephrata, Wash.	208,710
0C-1191	do	Jan. 27	Drains—blocks 16 and 161, schedules No. I, 1B, II, and IIB.	George A. Grant, Inc., Richland, Wash.	452,883
0C-837	Central Valley, Calif	Jan. 3	O'Neill Forebay recreation facilities phase II	Mann Construction Co., Inc., Redmond, Oreg.	673,265

UNITED STATES
GOVERNMENT PRINTING OFFICE
PUBLIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL



Discover . . .

RECLAMATION'S RECREATIONAL OPPORTUNITIES

Boating and water skiing on man-made lakes where not long ago only desolat desert sand stretched for miles around, fishing in clear waters once muddy wit silt . . . family picnics in cool, tree-shaded oases . . . sightseeing, huntin camping, swimming . . .

Discover all this when you visit any of the Bureau of Reclamation's 242 excitin recreation areas.

Discover our guide to these recreation areas. This guide lists by state ever dam, reservoir or area; the number of shore miles for each reservoir; all availabl facilities; the recreation uses (camping, swimming, water skiing); the annua visitor days of use; and the administering agency to whom one may write fo additional information.

Order your copy today, only 30¢ each, $22.50 per 100 or more copies sen to a single address. A limited number of free copies are available to school organizations, and individuals, by writing to: Bureau of Reclamation E&R Cente Building 67, Denver Federal Center, Denver, Colo. 80225, or to: Bureau o Reclamation, 18th & E Sts., NW., Washington, D.C. 20240.

MAIL ORDER FORM To:

uperintendent of Documents, Government Printing Office, Washington, D.C. 20402

osed find $................ (check, money order, or Supt. of Documents coupons). Please send me ....

es of RECLAMATION'S RECREATIONAL OPPORTUNITIES *at 30¢ per copy, $22.50 per 100 sent to a*

le address. S/N 2403-0071—1971 (I 27.2:R 24/10/971)

se charge this order

y Deposit Account

....

Name ....

Street address ....

City and State .... ZIP Code ....

FOR USE OF SUPT. DOC

____Enclosed________

To be mailed
____later________

____Subscription________

Refund________

Coupon refund________

Postage________

☆ GPO: 1972—O-457-194

FOR PROMPT SHIPMENT, PLEASE PRINT OR TYPE ADDRESS ON LABEL BELOW INCLUDING YOUR ZIP CODE

GOVERNMENT PRINTING OFFICE
LIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

RETURN AFTER 5 DAYS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFF

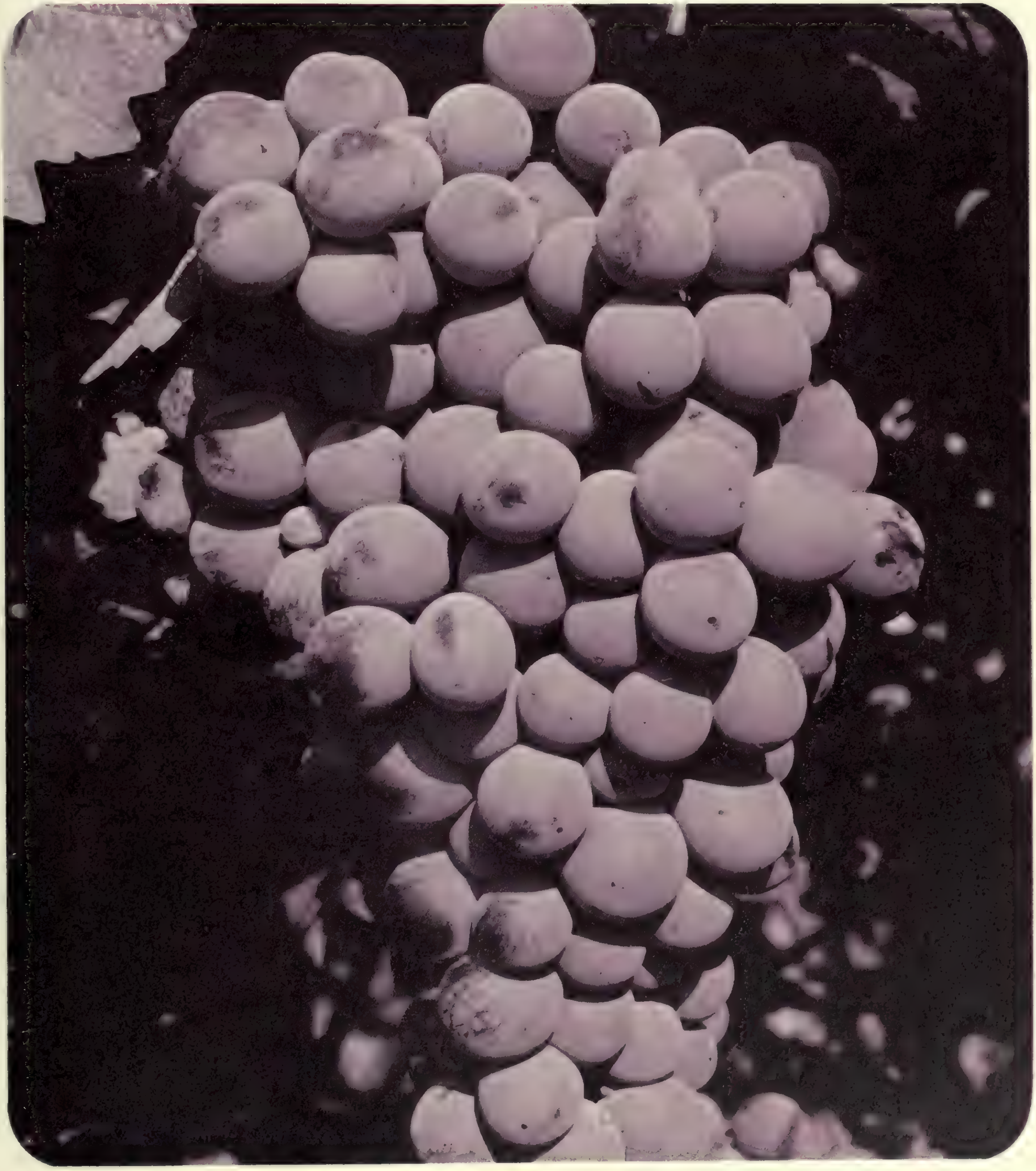
Name ....

Street address ....

August 1972

RECLAMATION era

A WATER REVIEW QUARTERLY



August 1972 • Vol. 58, No. 3

RECLAMATION era

Kathleen Wood Loveless, Editor

CONTENTS

COVER. Succulent Emperor grapes is only one of many varieties nourished by water supplied by the Bureau of Reclamation. Read of the raisin-making variety on the next page.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Project Skywater

For untold years man has sought to control giving rain and snow. And for almost as many year has progressed toward this goal. Only recently, how have scientists had the tools to understand what goe in the clouds. Most encouraging of all is the realiz that limited control of weather is definitly within capabilities.

It has been estimated that fifteen quadrillion ga of water pass across the United States during an ave year. Approximately 10 percent of this water naturally as precipitation. The water problem in United States is not so much one of too little precipita across the whole Nation, but that of a greatly dis portionate amount in individual areas.

Crops are destroyed—some by drought, som floods; residential areas are hampered or ruined agai drought or flood; and wildlife and livestock are easy to the whims of weather.

Since the Bureau was authorized by Congre 1961 to conduct research on weather modification, it been our purpose to mitigate the detrimental effec uneven distribution of precipitation.

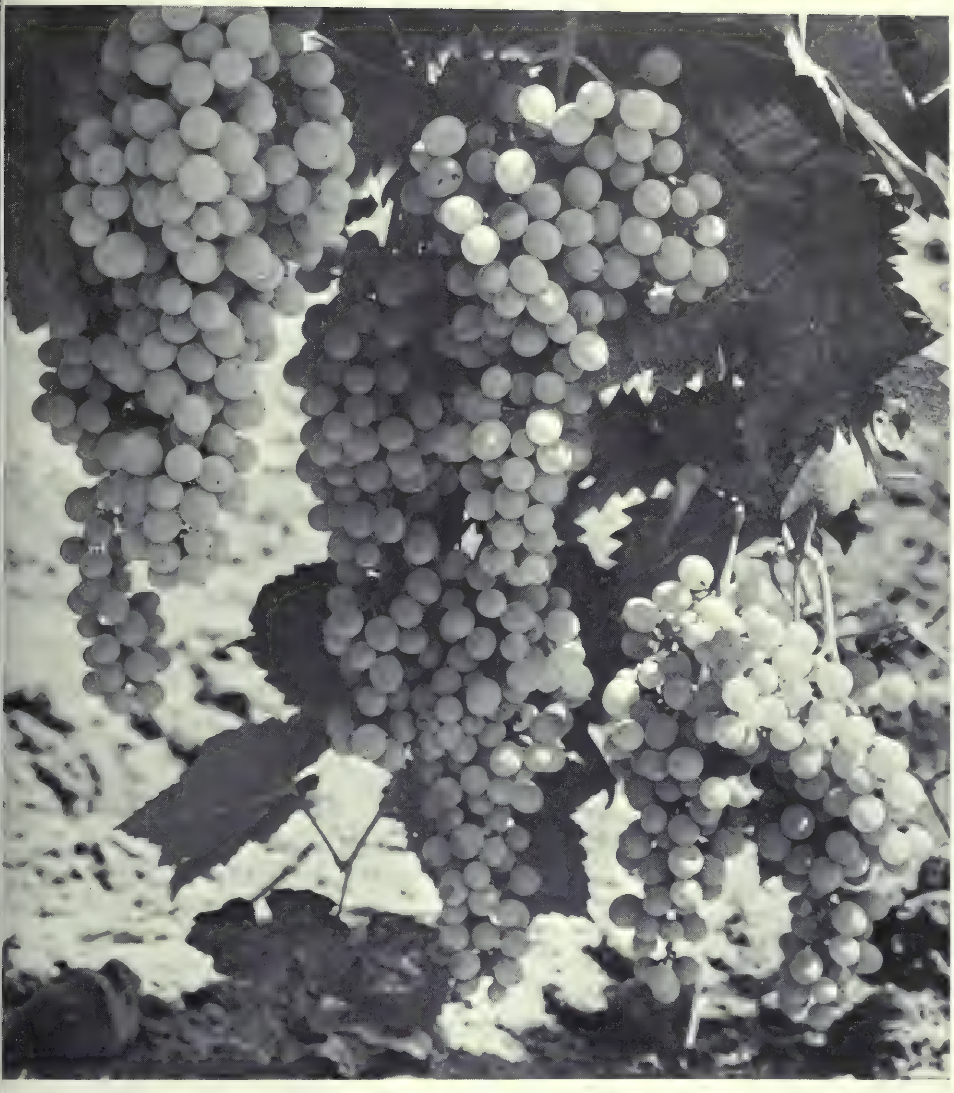
From the earliest days of Reclamation, our and reservoirs have served to control floods and eliminate the problems caused thereby, and at the time save water for periods of low flow.

Now we also focus our attention on the other lem—periods of insufficient precipitation. This is the pose of "Project Skywater"—research to determine added moisture may be induced from the sky by seeding.

The Colorado River Basin Pilot project is our ambitious undertaking, designed to evaluate an o tional winter-seeding program. The project area emb 3,300 square miles in the San Juan Mountains of s western Colorado, including several mountain str which contribute significant flows to the Colorado R And now we also engage in summer-seeding research.

There is no doubt that, under certain condit cloud seeding can increase precipitation. The incr range from a few percent to several hundred per Hence, with continued research, cloud seeding may be a practical and widely-used method of augme precipitation.

ELLIS L. ARMSTRONG
Commissioner of Reclam



Thompson seedless grapes in a vineyard near Fresno, Calif.

from GRAPES to RAISINS IN CALIFORNIA

Mechanical grape harvester in operation.

②

③

①

NOT many fruits are as delicious dried-up and lacking natural juices as are grapes. But then, grapes become raisins. The versatile grapes not only may grace your table as a sweet wine, but may garnish your morning cereal and cinnamon rolls, or even become eyes on a gingerbread man.

The transformation process is a bit more involved than one might suspect. Thompson grapes, one of the varieties commonly used for wine production and table consumption, are shown here as they grow in a vineyard near Reedley.

Irrigation water for the farmer in this are is supplied by the Bureau of Reclamation's Friant Kern Canal. The canal carries water from Friar Dam on the San Joaquin River, southerly fo supplemental and new irrigation supplies i Fresno, Tulare, and Kern Counties, an area o almost 1 million acres of highly fertile land i this southern portion of the San Joaquin Valley The irrigation facilities are part of the Bureau Central Valley project.

After adequate irrigation, sunshine and nutri ents, these grapes grow ripe and ready for ha

⑤

⑥

vesting. This mechanical grape harvester in operation on a Thompson seedless grape vineyard near Fresno has greatly reduced the laborious work of grape-picking.

This closeup of the mechanical grape harvester shows the sifting method used to separate fruit from vine. ①

After harvesting, the grapes are loaded onto a truck, which will transport them to their next destination—the packing plant. ② ③

Those grapes which will be turned into raisins require an additional step before trucking. Here, farm workers are turning paper trays of harvested Thompson seedless grapes in a vineyard near Sanger on the east side of the San Joaquin Valley. This process provides for even drying by the sun. Considered the raisin capital of the world, this area is replete with vineyards. ④

After the grapes are dried for raisins, they are rolled up in the paper trays. From the field these rolls are taken to a nearby plant for further processing, then shipped to the consumer. ⑤

The final result—delightful, ready-to-eat raisins. ⑥

# # #

Snow for the SWITZERLAND of AMERICA

by **WILLIAM J. DOUGLAS, Research Meteorologist, Engineering and Research Center, Bureau of Reclamation, Denver, Colo.**

ON the narrow highway, wending a serpentine path that offers spine-tingling views, cars bearing out-of-state licenses form an almost constant summer caravan under the face of southwest Colorado's spectacular San Juan Mountain range.

Even now, while the calendar proclaims summer, there is a chill to the winds that play about the 14,000-foot peaks here in what is known as the "Switzerland of America."

Of the thousands of tourists who visit this alpine wonderland, it is likely that few of them are aware that nearby is the site of a scientific research project that has captured international attention and that holds immense promise for water-short areas of the western United States.

Colorado River Basin Pilot Project

It is the Bureau of Reclamation's Colorado River Basin Pilot project, designed to determine how cloud-seeding can most effectively be applied on a large-scale basis to augment runoff of the Colorado River, the lifeline of the seven states which it touches or to which it contributes its runoff.

As summer of 1972 wanes, teams of meteorologists and other scientists, technicians, and student research assistants prepare for the third consecutive winter season of cloud-seeding operations in the project area that lies along the windward side of the Continental Divide, rooftop of the Nation. The work is not confined to men of science. Housewives, ranchers, and a sprinkling of high school students are among those employed in the pilot project.

The project area (1,600 square miles), is larger than the entire State of Rhode Island. The project commands the services of some 150 full- and part-time employees. More than 200 instruments and gages are installed and used in and around the

These students are measuring and recording dimensions of flowering plants near Williams Fork Lake in the San Juan Mountains. They are associated with the ecological studies of the San Juan Mountains.

Dr. Archie Kahan shows Clem Todd (L) and Robert Trainor (R), the influence of silver iodide (AgI) on a supercooled cloud, and the trajectory of snowfall on the face of a mountain barrier. All three are employees of the Bureau of Reclamation.

The Springhill precipitation gauge is serviced by this operator who, during his 3-day stay, maintains the silver iodide generator, tracks balloon releases, and services other weather recording instruments.

target area. They record great masses of data on wind and temperature, pressure and precipitation, on a day-to-day, hour-by-hour basis.

From these data, Bureau of Reclamation scientists expect to provide definitive answers to the questions: What additional precipitation does cloud-seeding 1972 model, provide? At what cost? With what reliability? Under what conditions? And what are the physical, social, and environmental considerations?

Project Skywater

To explore these and other issues, the Bureau of Reclamation conducts a $6-million-a-year research program dubbed, "Project Skywater." It involves special studies and activities by 44 contractors in 20 states. The Colorado River Basin Pilot project is one of three field programs (others are in North Dakota and Nevada) that represent a critical link in the scientific transition from basic research to operational adaptation.

Project Skywater is directed by the Division of Atmospheric Water Resources Management at the Bureau's Engineering and Research Center in Denver. The project was born in 1961, when the Congress appropriated $100,000 for Reclamation to explore cloud seeding as a possible water resources tool.

The Colorado River Basin Pilot project was conceived in 1968, but because of extensive planning requirements, seeding was not begun until the winter of 1970–71.

The operation involves careful analysis of winter storms as they approach the mountainous target area. As warm moist air is forced up and over the Continental Divide, clouds are formed which deposit much of their burden of snow on the southwest-facing slopes of the massive San Juan Mountains.

Seedable Storms

Based on criteria related to temperature, humidity, and other factors, about half the storms are considered "seedable." When a "seedable" storm comes along, a random decision is made whether or not to treat it—that is, to seed it with silver iodide crystals produced by a network of 33 ground generators located upwind of the target area. Only about half of the "seedable" storms are seeded.

Extensive data are collected on each storm by a host of airborne and ground instruments to be analyzed on the basis of seeded versus unseede cases. After two winter seasons of operations Project Skywater officials say a preliminary com parison shows a significant increase in precipita tion from seeded storms. But a more comprehen sive assessment must await the full term of th pilot project—that is, four, possibly five winte seasons of randomly seeded storms that meet cri teria, followed by a scientific examination of th results.

"We are searching," says Dr. Archie M. Kahan Chief of the Bureau of Reclamation's Division o Atmospheric Water Resources Management, "fo a faint signal against a very noisy background unfailing scientific evidence that man can impos a positive effect on a natural phenomenon tha varies widely and frequently."

Dr. Kahan joined the Bureau in 1965 after distinguished career in which he engaged in re search and administration at Texas A&M Uni versity and later at the University of Oklahoma Notwithstanding his scientific restraint, Dr. Kaha occasionally exhibits a romanticist's appreciatio for such sights as a flotilla of fleecy clouds parad ing across a blue summer sky.

Lifeblood of Rivers

Indeed, summer clouds and their stimulatio for added rainfall are an important part of Projec Skywater research. But in directing the Colorad River Basin Pilot project, Dr. Kahan and hi staff are most concerned with winter storms tha provide the lifeblood of all western streams an rivers.

Snows deposited in the high mountains fee them all. The river's flow is governed by th amount and character of the mountain's snow pack. The snowpack is, in turn, a product of th uncertain and infrequent storms that travel th winter skies over the Rockies.

"Mankind has yet no way of influencing the fre quency of such storms," explains Dr. Kahan, "No can we influence precipitation from all kinds o atmospheric circumstances. But we *are* learning the means by which we can improve the precipita tion production of certain kinds of clouds."

An important stepping stone toward this knowl edge was provided by Lewis Grant, professor a Colorado State University and more recently a consultant to Project Skywater. During the late 1950's and early 1960's, Professor Grant and his staff conducted seeding experiments on winter-

ne clouds in the Colorado Rockies for both the tional Science Foundation and for the State Colorado.

ver Iodide is Released

After hundreds of seedings, they found that ecipitation increased when silver iodide crystals re released into clouds whose uppermost temrtures ranged between minus 5° and minus 23° ntigrade. It is in this temperature range that ver iodide functions best, and that naturally curring materials are least effective in furnishg the nuclei needed to produce precipitation.

The critical role of these temperature values seeding winter clouds is well established, but pilot project now seeks additional data.

"Simply stated," says Dr. Kahan, "our objective to be able to report that, by cloud seeding, we n produce *x* acre-feet of additional water at a st of *y* dollars and with a statistical reliability of We hope to accomplish this in a socially acceptle and environmentally sound fashion. We in e Bureau of Reclamation have the responsibility assigning hard values to the unknowns—*x*, *y*, d *z*."

When the pilot project was conceived in 1968, e Bureau of Reclamation called on Professor rant and Colorado State University to prepare the design. It proposed the random seeding of storms meeting specific criteria for a period of at least four winter seasons, to provide a number of cases of seeded and unseeded storms sufficient to yield statistically significant results.

San Juan Region Chosen

Selection of the operations area was of major importance. The San Juan region was chosen for its contribution to the Colorado River runoff through a number of tributaries; for the presence of an existing network of precipitation gages and other instruments; and because virtually the entire region is publicly owned.

Individual contractors were selected to conduct seeding and field activities, to install the instruments and to collect data for the full period of the project. EG&G, Inc., through its Environmental Services Operation at Albuquerque, N. Mex., is the seeding contractor and Western Scientific Services, Inc., of Fort Collins, Colo., is responsible for the instrumentation and data acquisition. Both have established offices at Durango, Colo., headquarters for the project.

Communities Question Project

Residents of mountain communities near the project area were less than enthusiastic when the project was first announced. They voiced fears of record amounts of snow, of spring floods and winter hazards, of an abbreviated summer tourist season, of groundwater conditions that would imperil mines that contribute heavily to the area's economy.

These and other concerns were answered (and a spirit of mutual trust was born) in a series of public meetings in several comunities: Silverton, Telluride, Ouray, Lake City, and Pagosa Springs.

Three times hearings were conducted in those communities where interest ran high. To keep residents and local and State officials fully advised of developments, a Project Skywater newsletter was developed by the Division of Atmospheric Water Resources Management and is mailed at frequent intervals to a list that has grown to nearly 250 persons.

At public meetings, in correspondence, and in frequent and casual conversations between Proj-

Harold Halverson, as do many ranchers near the Durango–Pagosa Springs area, operates a burning silver iodide generator.

ect Skywater officials and local residents, the exchanges were sometimes brisk and always honest. They demonstrated that the project was flexible, and that residents had the opportunity to shape it in significant ways.

Avalanche-Prone Area

"We live in the most avalanche-prone area of the Nation," local citizens said. "What do you propose doing about this threat?"

There are, in fact, 49 specific avalanche runs that intersect the "Million Dollar Highway" (U.S. Highway 550) that links Silverton and Ouray. These steep courses pose a very real hazard to motorists in the winter. But, it is not known whether or not additional snow would increase this hazard. What, indeed, might be done?

Even though the highway and the communities are outside the seeding target area, the Bureau turned to the University of Colorado's Institute of Arctic and Alpine Research (INSTAAR) for an intensive study of avalanches to determine what causes them to occur at particular momen and how they may be forecast, diverted, controlled.

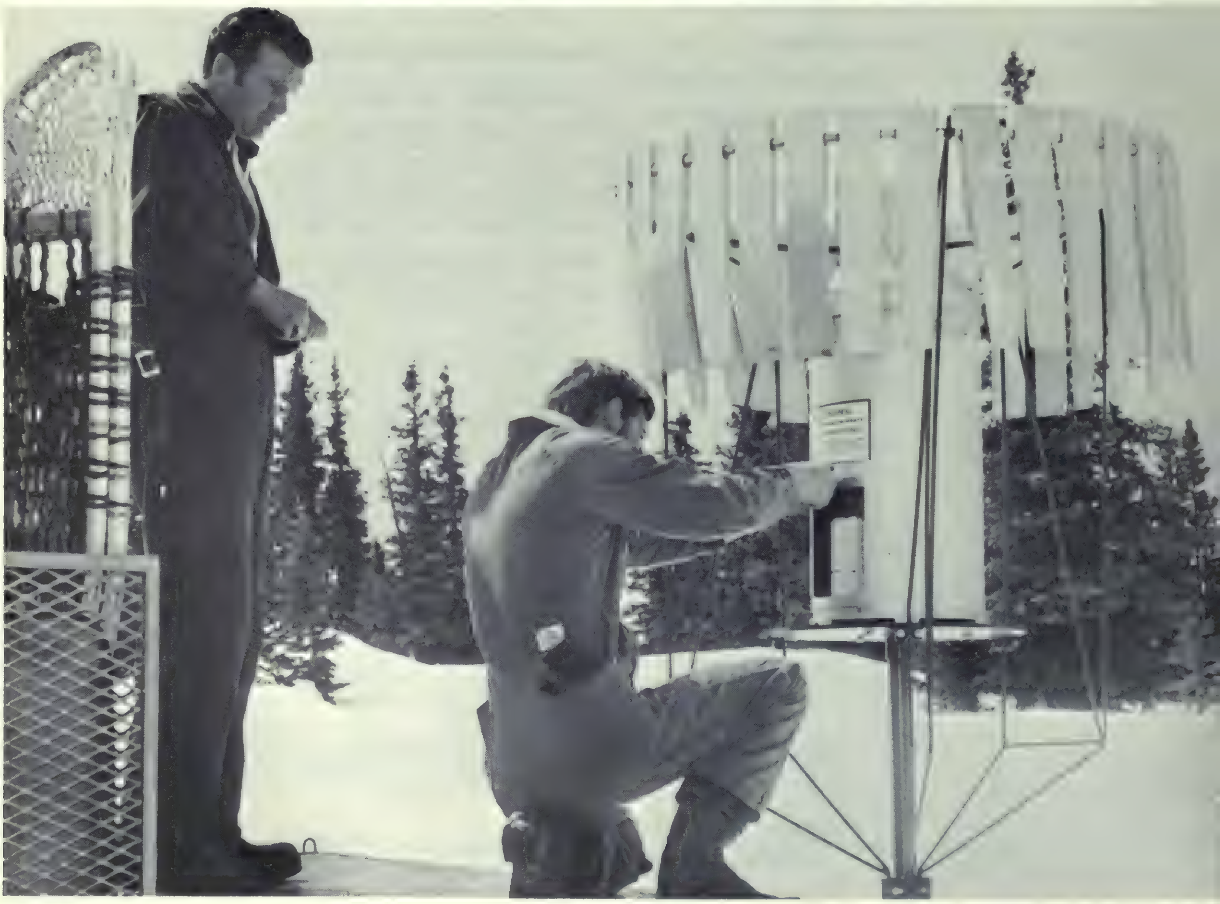
Howitzers Used to Shoot Avalanches

Highway crews and ski operators have u recoilless rifles or howitzers to shoot avalanch the most common control technique. Not alwa of course, have they beaten nature to the pun The Colorado Division of Highways uses th 75 mm. howitzers, on loan from the Natio Guard, in its avalanche-control program. Dur the 1960's, the Division built a massive conc snowshed at the site of one of the worst avalan runs atop Wolf Creek Pass, which lies nearly the geographic midsection of the Colorado Ri Basin Pilot program.

Despite these controls, however, little eff has been directed in this country to accurate und standing of the avalanche phenomenon or to novative steps to control the devastating sli

Last winter, in performance of the Reclamat

Like all instruments used by Project Skywater, this precipitation gauge must be carefully operated; here, the chart is being changed.



Lifting components for the San Juan weather station—the highest unmanned station in the United States—is this French-made turbo jet helicopter.

ontract, a five-member INSTAAR team took up esidence in Silverton and established a mounain-top observation post where, during snowtorms, they made exhaustive studies of snow ensity and accumulation in known avalanche reas. They also measured and evaluated scores f slides during the winter in an effort to build an valanche "profile" from which new ways could e found to anticipate and control nature's "white errors."

nvironmental Effects

What are the environmental effects of cloud eeding? Environmental considerations previously iewed academically attracted new recognition vith the pilot project. Already in progress was a pecial study by a University of Michigan research eam into the ecologic effects of weather modificaion. Completed in 1969, the study suggested any hanges produced by cloud seeding probably vould be gradual and subtle, some for better, some ossibly for worse. But, research was needed!

To explore the study's theoretical findings, an ntensive ecologic investigation was ordered as art of the Colorado River Basin Pilot project. It s being conducted by Colorado State University, he University of Colorado, and Fort Lewis Colege of Durango, Colo.

The ecologic studies continue year round, and mphasize items most sensitive to ecologic hange—that is, living things that provide the arliest and most reliable barometers of possible hange. Among them, curiously, are boreal toads—mphibians that are among the most fragile inabitants of the alpine ecosystem.

These and other occupants of the project area—quirrels and shrew, elk and rabbits, flowers and ative grasses—are counted and catalogued so hat their numbers and growth may be monitored n selected test plots throughout and beyond the eriod of the pilot project.

Another part of the ecologic study involves the econstruction of the area's climatic history. No ormal records now exist, so tree-ring dating is n progress to enable scientists to build a weather istory and ot determine what trends may already e in progress as a natural step in the area's volution.

Natural Change in Climate

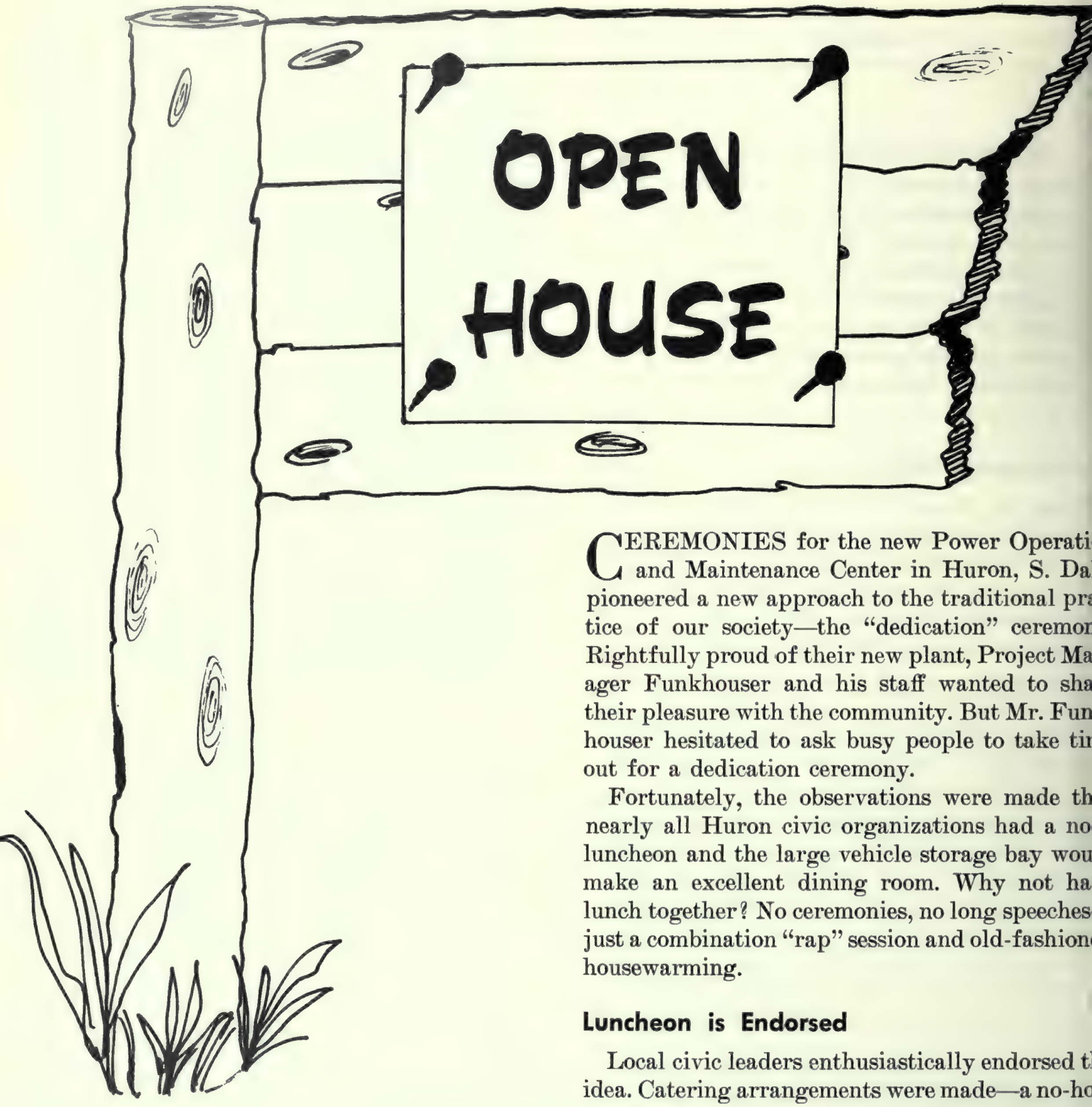
"It is eminently reasonable to postulate that the San Juan Mountains may be experiencing a (natural) shift in temperature and precipitation," say the ecologic investigators. "If this is true, then it follows that the ecological conditions of the target area are already shifting in response to this natural change in climate."

Thus what began, 4 years ago as a research program to evaluate cloud seeding as a tool to augment water for the Upper Colorado River Basin has taken on a much deeper character, with far greater dimensions than originally envisioned.

"We have not lost sight of out goal," says Dr. Kahan. "Our mission remains one of determining the worth of cloud seeding as an economic, efficient, socially acceptable and environmentally sound water augmentation tool. The complexities of that challenge are nothing short of staggering, but they are enormously exciting. We have made enormous progress. We shall achieve our goal.

"Particularly gratifying is the awareness that scientific investigation spawns new ideas, new objectives, and new benefits to mankind. We have rediscovered these truths with the pilot project."

# # #



by **GEORGE W. CAREY,**
Bureau of Reclamation,
Missouri-Oahe Projects Office,
Huron, S. Dak.

CEREMONIES for the new Power Operati and Maintenance Center in Huron, S. Da pioneered a new approach to the traditional pr tice of our society—the "dedication" ceremor Rightfully proud of their new plant, Project Ma ager Funkhouser and his staff wanted to sha their pleasure with the community. But Mr. Fun houser hesitated to ask busy people to take ti out for a dedication ceremony.

Fortunately, the observations were made th nearly all Huron civic organizations had a no luncheon and the large vehicle storage bay wou make an excellent dining room. Why not ha lunch together? No ceremonies, no long speeches just a combination "rap" session and old-fashion housewarming.

Luncheon is Endorsed

Local civic leaders enthusiastically endorsed t idea. Catering arrangements were made—a no-ho luncheon schedule was developed for the week November 29 to December 3, 1971. We ev wheeled in specialized equipment for decoratio

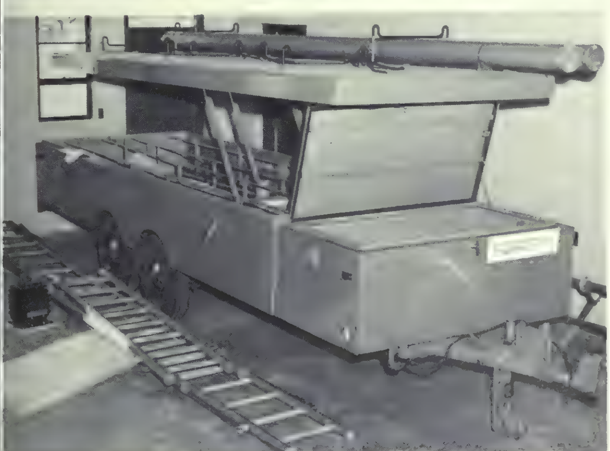
On Monday, November 29, the Sertoma Cl kicked off the first of a series of luncheons inclu ing those of the Lions, Kiwanis, Rotary, Opt mist, and High Twelve.

The local civic organizations, as well as othe interested, including Bureau of Reclamation en ployees, enjoyed the luncheons and had the oppo tunity to inspect the new facility and the specia ized equipment used to maintain the Bureau power transmission system. About 300 peop attended.

nlike most "open houses", the Bureau's Operation and aintenance Shop Building provides headquarters nd shop facilities for all maintenance persnnel in Huron lus storage bays for specialized equipment.

For 5 days well-attended luncheons were held in the storage bay.

Jsed as decoration, this 345 KV Hotline Trailer added o the atmosphere of the luncheon. It is used to store tools ieeded for work with high voltage transmission lines.



The 60- by 120-foot building provides headquarters and shop facilities for electrical, electronic, meter, and relay crews; it also provides storage for specialized equipment used to maintain the Bureau's power transmission system. The foundation is concrete caissons spanned by concrete grade beams. The upper roof beams are precast, prestressed concrete double tees supported by concrete walls. Curtain walls, nonbearing exterior walls, and all interior walls are of concrete masonry unit construction. Roofing is foamed-in-place rigid urethane insulation with silicone rubber coatings.

Construction Began in 1950

Construction of facilities began in 1950 for marketing the power generated at the hydroelectric plants on the main stem of the Missouri River. Facilities constructed since that time, under the Huron Office supervision, include over 3,600 miles of transmission line and 37 substations with approximately 3 million kilovolt-amperes ((kv.-a.) of capacity in South Dakota and adjacent states.

During the summer of 1970, construction was completed on the 345-kv. line running from Fort Thompson, S. Dak. to Grand Island, Nebr., including new substation facilities at each end of the line. These new facilities relieved a critical power supply problem in Nebraska. They also served as the major link permitting the integration of Nebraska's summer peak loads with North and South Dakota's winter peak loads, thus reducing required overall generating capacity. This is the first extra-high-voltage transmission line constructed by the Federal Government in the Missouri River Basin.

Markets Electric Power

The Bureau's Huron office is responsible for marketing electric power in South Dakota, western Iowa, eastern Nebraska, and southwestern Minnesota. The office is also responsible for conducting studies and preparing design data for transmission lines, substations and other facilities required to deliver power to load centers.

The Huron office establishes and maintains frequent contact with existing and potential Bureau customers, and operates and maintains transmission lines, substations and other facilities including control, communications and protective devices. # # #

by HAROLD E. ALDRICH, Regional Director,
Bureau of Reclamation, Region 6, Billings, Mont.

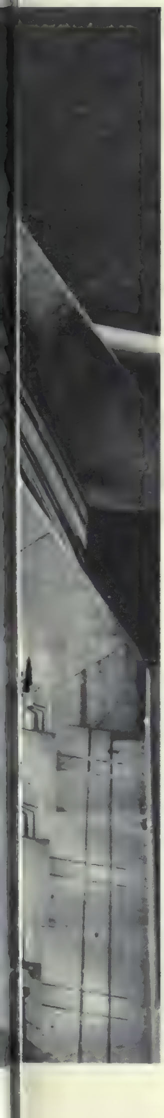
Ashes to Ashes
DUST to DUCKS

Canyon Ferry Dam which creates Canyon Ferry Lake is a concrete, gravity type, 225 feet high structure with a spillway capacity of 150,000 cubic feet per second.

The mudflat caused by the drawdown will be enclosed by a dike up to 15 feet high and nearly 3 miles long.

AT 10 a.m. on March 23, 1972, the Bureau of Reclamation opened bids at Townsend, Mont., for the construction of dust abatement installations at Canyon Ferry Lake. In many ways, that event was just another bid opening. In one way, however, it marked a significant milestone in the history of the Bureau's program for a livable environment.

Back in 1902, the basic Reclamation Act made no mention of multipurpose reservoirs, nor of their effect on the environment. The body of law under which the Bureau of Reclamation operates today is the result of slow and sporadic development, largely under conditions far removed from today's public demand for full environmental consideration. Although people from all over the Nation are enjoying recreational, fish and wildlife, and other environmental benefits on many of the older projects built by the Bureau of Reclamation, these benefits are provided incidentally by reservoirs justified and built for other purposes.



Parched and cracked, the lakebed soon turns to blowing dust.

Looking across the upper end of Canyon Ferry Lake from the west shore, one can see the blowing dust sweep across the reservior shoreline.

Now, An Era of Change

The Canyon Ferry Unit of the Pick-Sloan Missouri Basin program was born in this era of change. It was authorized for specified multipurpose use, but the public demanded a vastly more efficient utilization of its water supply and of the facilities used for its regulation and enjoyment. It was used for flood control purposes from its first filling in 1954, but there was no space officially allocated to flood control in the reservoir area until 1966.

Although provision was made during construction of the dam for fish and wildlife enhancement recommended by the Montana Department of Fish and Game, the Bureau had no mandate to stabilize the lake level during goose-nesting period, which it has done whenever possible.

The Bureau has constantly worked to provide the best possible uses of the available water supply, even though the users were frequently highly competitive. Unfavorable impacts such as reservoir fluctuation, mudflats and blowing dust were inevitable.

The original operating plans for Canyon Ferry had to assume—in the absence of specific enabling legislation—that water storage involved certain ecological costs the community and society were willing to pay in exchange for the benefits derived.

Government's Policy for Good Environment

The National Environmental Policy Act of 1969, together with other state and Federal legislation relating to environmental pollution ushered in a new era. It is now a recognized policy of the Federal Government to use all practicable means to create and maintain conditions by which man and nature can live in productive harmony.

Canyon Ferry can no longer be regarded simply as a storage reservoir for certain purposes—it is what the ecologists call a "manmade lake," with all the wide-ranging ecological and social consequences that the name implies. Its storage water, its overlying air, its plant and animal life, together with the people who pursue their activities in the lake area, now constitute a classic example of the ecosystems that must be considered in resource development and use.

The Bureau of Reclamation is proud to share with the people of the Canyon Ferry community the responsibilities as trustees of that ecosystem. These are also shared by the National Park Service, Bureau of Sport Fisheries and Wildlife, and the Montana Fish and Game Departmnet, who assisted the Bureau in preparing the plan for dust abatement and wildlife preservation and enhancement. The Bureau believes that when the program is completed, it will enable local people and succeeding generations to attain the widest range of beneficial uses of the total environment without degradation or risk to health and safety.

But the local people don't have to wait for future generations to realize the favorable impact of this work.

The Dust Problem

Unlike most tides which are daily, the fluctuation of Canyon Ferry Lake is annual. The inevitable result is the exposed lakebed dries during the low water and the fine sand is swooped into the air by gusts of wind.

When these dust storms sweep across highways, motorists have difficulty seeing the road and oncoming traffic. Windowsills of Townsend dwellings are coated with dust. Dust-laden crops bear mute witness of the farm problem.

But, the Bureau of Reclamation is resolving the problem—the Canyon Ferry dust control program is being undertaken which, at the same time, will transform the mud flats from which the dust comes, to permanent pools of shallow water which will provide nesting habitat for waterfowl.

The work proposed (as shown in the artist's concept) includes about 10 miles of silt-retention dikes of a maximum height of 15 feet to be constructed on both sides of the reservoir, creating 1,870 acres of ponds. These will be constructed di-

The dredge tailings (foreground) will be used to construct zone 2 of the Westside Dike in the dust abatement program.

The artist's concept of the supply canal.

rectly on the lakebed by using gravelly materials from nearby borrow areas.

Silt deposits on the lakeside of the dikes will be excavated by hydraulic dredge and deposited behind the dikes to eliminate dust sources from the lakeside areas. The deposited material will act as a sealant for the ponds and dikes.

The program will require an estimated expenditure of $5,100,000 for construction of canals, dikes and dredging operations over a period of about 5 years. This construction will have a noticeable impact upon the local and regional economy. On-site employment is estimated to equal about 80 man-years to accomplish the construction work.

The work involved will employ labor from various trades, including equipment operators, truck drivers, dredge operators, dredge hands, mechanics, cement masons, laborers, foremen and supervisors. In addition, substantial quantities of fuels, lubricants, and other materials and supplies will need to be purchased. However, the work will be seasonal due to climate, ice cover and water elevations in the reservoir.

A Bonus for the Community

A feature of this construction which may be considered a bonus for the community is that the Bureau scheduled it over a 5-year period for two reasons: (1) To eliminate the need for the huge capital investments in machinery and equipment a "crash" program requires and (2) to permit local contractors to incorporate the seasonal part of this job into their construction schedules. Except for dredging, local and nearby contractors were in an excellent position to compete in bidding since all work was set aside for small business.

Islands for Waterfowl

The impoundments will be filled with water to a depth of 3 to 5 feet by ditches from the Missouri River upstream from the ponds. A system of waterways and open drains between impoundments will protect the facilities from excessive surface runoff from intensive rainstorms. Islands for waterfowl nesting and resting will be constructed during the dredging operations.

A section of the lake, a wasteland and a source of dust when intermittently exposed, will thus be converted to an area of beneficial use without changing the basic functions of Canyon Ferry Unit. Problems created by the dust blowing from this section of the lake will be greatly reduced. At the same time, excellent aquatic wildlife habitat will be developed at the impoundments.

The quality of life will be improved and adverse effects on livestock and forage crops will be reduced, thus benefiting the economy of the area.

This aerial view shows the location of the proposed canal and dikes. The town of Townsend, Mont., is in the foreground.

Marsh Attracts Ducks and Geese

The shallow marsh areas will be highly attractive to the breeding population of ducks and geese using the Missouri River, which is in one of the major flyways of Montana. The impoundments will complement the use of adjacent Federal land acquired for Canyon Ferry Lake, administered by the Montana Fish and Game Department for recreation and fish and wildlife purposes.

Safe nesting areas for geese will be available along the perimeter of the impoundments and on the islands planted with suitable vegetation. Stable water levels in the impoundments will encourage aquatic vegetation for food and cover. The marsh area will accommodate an estimated 600 man-days of hunting each year plus trappings for fur bearers.

Ecology Classroom

With the abundance of wildlife anticipated, the area could become an "ecology classroom" as a demonstration of what man can do when he enhances the environment for the benefit of both wildlife and man.

When completed, operation and maintenance of the proposed dikes, water supply facilities, and relief drains will be performed by personnel of the Bureau of Reclamation, in cooperation with the Montana Department of Fish and Game. Bureau personnel will periodically adjust river diversions to supply canals and water deliveries into pounds, and will perform necessary maintenance work on the facilities.

The Montana Fish and Game Department, in furtherance of the development of new wildlife facilities at Canyon Ferry Lake, has indicated its intent to share costs of the plan by assuming operation, maintenance, and replacement costs, estimated at $20,000 annually. That agency will administer the wildlife areas as a part of the current management plan for the Federal lands of the Canyon Ferry Unit. Bureau of Reclamation and State officials will soon meet to revise and update the existing plan for management to include the new dust control program. # # #

Along with the marsh which will be provided for ducks and geese, a total of 700,000 of these 4 to 6 inch rainbows will be planted in Canyon Ferry Lake this summer.

WATER Quiz

1 The Bureau's Central Valley project in California produces tremendous quantities and many varieties of fruit. What is the name of the California-grown fruit shown here? →

a. quince c. Scarlet Pearmain apple
b. persimmon d. pomegranate

2 In science, water is a standard for the representation of certain units. Some of these are:

a. the liter c. both of these
b. the calorie d. neither of these

3 What is the purest natural source of water?

a. snow
b. mountain stream water
c. rain

4 What connection is there between the high stairs of these Sacramento homes and the Bureau of Reclamation? →

5 List these events in order of their place in the water cycle, starting on a sunny afternoon.

a. rain or snow
b. evaporation from water and plant surfaces
c. condensation
d. runoff—such as streams and underground water

Answers on page 24.

Yesterday
in Our Magazine

THE RECLAMATION ERA—1935

The Boulder Canyon Project

THE results to be expected from the construction of the Boulder Canyon project are as follows:

1. Will help alleviate the serious economic situation brought about by the general[ly] depressed conditions throughout the country.
2. Will provide flood control.
3. Will provide an adequate water supply for irrigation and domestic use.
4. Will provide silt control.
5. Will improve navigation on the river below and above Black Canyon.
6. Will create a new recreational area.
7. Will permit the generation of power, the returns from the sale of which will repay the entire cost of the project.

On July 30, 1930, President Hoover signed the deficiency act, carrying an appropriation of $10,-660,000 for initiating construction of the project. Four days later Order No. 436 was signed by the Secretary of the Interior directing the Commissioner of the Bureau of Reclamation to commence construction on Boulder Dam and the Bureau actually put men to work at the damsite on that day.

Although not so intended in the original setup, this project became the first to aid in the problem of unemployment during the years of depression. Work was going ahead on the drawings and designs in the Bureau's Denver office when word was received from President Hoover to start construction as soon as possible in order to aid in alleviation of the unemployment conditions.

Boulder Canyon project, Arizona–Nevada—Reservoir starts to fill.

today...

Reclamation Era—1972

THE Colorado River has been a menace to life
. and property along its banks for many years.
ıe need for a comprehensive plan of develop-
ent to check the enormous energy is being met
the Boulder Canyon project. It now includes
oover Dam (prior to 1947, known as Boulder
am), the powerplant on the Colorado River, and
e All-American Canal System. Lake Mead, the
servoir behind Hoover Dam, with a total capac-
of nearly 30 million acre-feet, will hold the
tire flow of the river for 2 years.

The results expected in 1935 from the construc-
on of the Boulder Canyon project were achieved
d still are being realized:

1. It did help alleviate the serious economic situ-
ion by employing an average of 4,000 men for
-year period with an average payroll of $600,000
r month.

2. There has been no flooding in the lower Colo-
do River since the dam was built.

3. It supplies water for irrigation to 500,000
res of land in the United States and 500,000 acres
Mexico; and it supplies water for domestic and
dustrial use to more than 10 million people.

4. It provides silt control. Water leaving
oover Dam is clear.

5. Upstream from the dam, the river is naviga-
for 110 miles when the lake is full. Below the
m, the river is navigable 67 miles to the next
m downstream.

6. Lake Mead has become one of the Nation's

Hoover Dam and Lake Mead as they look today.

most popular recreational areas. More than 5 million persons visit the area each year to sightsee, swim, fish, boat, and camp.

7. The sale of electrical energy will pay back the cost of the project plus interest by 1987 except for $25 million allocated to flood control.

SACRAMENTO-SAN JOAQUIN DELTA

A MAN-MADE ENVIRONMENT

by JIM COOK, Acting Chief, Delta and Bay Area Branch, Regional Planning Office, Bureau of Reclamation, Sacramento, Calif.

THE 450-mile-long Central Valley lies in the northern and central portion of California, bounded on the east by the Sierra Nevada Mountains and on the west by the Coast Range. The Sacramento River flows southerly and the San Joaquin River flows northerly through the valley floor. They join in the Delta and reach the Pacific Ocean after passing through the Delta, and Suisun, San Pablo, and San Francisco Bays.

The combination of rivers, sloughs, islands, and mudbanks commonly known as the Delta lies at the confluence of the Sacramento and San Joaquin River systems about 40 miles northeast of San Francisco. The 740,000-acre Delta contains about 50,000 acres of water surface consisting mainly of over 700 miles of meandering waterways which separate islands and tracts of rich farmland.

The Delta's land area consists of peat, alluvium and organic soils from 5 to 80 feet below sea level. Water levels in the Delta channels rise and fall from 3 to 5 feet each day due to the tidal influence of the Pacific Ocean. The Delta is extensively developed for agriculture.

A Tidal Marshland

Prior to 1849, settlers avoided the Delta, considering it a tidal marshland inhabited by wildfowl and beaver. With the discovery of gold at Sutter's Mill in the foothills of the Sierra Nevada, the sedentary way of life of the few settlements strung out around the Delta was completely disrupted as tens of thousands of people poured into California. New settlements sprang up around the early Spanish land grants which skirted the Delta between Stockton and Sacramento. The influx created a need for a more intensive and diversified agriculture.

Many miners, frustrated in their search for gold sought a more certain fortune by tilling the ric soil along the banks of Delta waterways. As th demand for foodstuffs intensified, the farmers en croached farther and farther into the Delta marsh land. Low artificial mounds, or "shoestring levees as they were appropriately called, were constructe to hold back Delta waters. However, they wer capable of withstanding little more than a hig tide.

Winter flooding in the 1850's demonstrated th need for levee protection of Delta farmlands. Earl attempts to construct levees were hampered b high costs and a strong feeling that floods coul be controlled by facilities in the Sacrament Valley.

Development Begins

Great strides were taken in the next half cen tury in the development of reclamation technique and equipment. Mechanical power was applied t dredging, levee building, ditching and land clear ing. Pumps were introduced in 1876 to contro water levels on reclaimed land. During the 1870's interest in swampland reclamation was at a peal Levee building projects ultimately transforme the Delta from an imperfectly drained flood plai to a productive farming region.

In addition to reclaiming the land area, ne fish species—striped bass, American shad, an white catfish—were introduced. Quail and othe game birds were brought into the Delta and re leased. Imported varieties of orchard and fiel crops were planted and new breeds of livestoc were introduced into the area.

Ironically, man's attempts to develop the seem ingly boundless resources of California were pro ducing problems as far reaching as his achieve

These hearty fishermen display the fine fish that can now be caught in the delta area.

nents. From 1860 to 1914 more than 800 million cubic yards of mining debris from upstream mountains passed through the Delta, raising the beds and constricting all channels. In addition, higher levees and reclaimed land reduced the flood plain area. Thus, salt water began to penetrate further into the Delta.

River Flows Decrease

This problem was further compounded when flows of the Sacramento and San Joaquin Rivers began to decrease due to upstream development. Also, water of the San Joaquin River system deteriorated, hence poor quality water flowed in the river for longer periods each year because of increasing agricultural use and waste water return flow in upstream areas.

An interesting indicator of water quality in the Delta area during these early years was provided by operating records of the California and Hawaii (C. & H.) Sugar Co.'s water barge. During years of low stream-flow into the Delta, the high salt content offshore from the company's plant at Crockett on the Carquinez Strait required hauling water from the interior Delta to meet processing needs. During the drought of 1918–20, the search for fresh water carried the barge almost to the city of Stockton on the eastern edge of the Delta.

This drought resulted in extensive abandonment of newly irrigated lands in the San Joaquin Valley where rapid development of irrigation pumping had lowered the ground water. Salinity in the Delta forced virtual abandonment of the Delta channels as a source of water.

In 1921 the State Legislature authorized an extensive investigation by the State Engineering Department to develop a comprehensive plan for conservation, control, distribution and use of all the waters of the State for the most beneficial purposes.

CVP Authorized

Federal and State interests spent years studying designs and the funding of needed water works. After litigation and negotiation between areas of water supply and areas of water need and after lobbying by various interests, the Secretary of the Interior was authorized by the 1937 Rivers and Harbors Act to construct a Central Valley project (CVP) in accordance with Reclamation law.

With the advent of the Central Valley project, the waterways of the Delta became part of a water conveyance system. Water from the upstream reservoirs is drawn across the Delta channels and

through the Delta Cross Channel (CVP–1951), a mile-long channel constructed between the Sacramento and Mokelumne River systems, to export pumps serving the Contra Costa Canal (CVP–1948) and the Delta Mendota Canal (CVP–1951).

In addition to meeting contract requirements for water quality at these export pumping locations, the cross-Delta water transfer has assured availability of quality water to interior Delta water users since the construction of Shasta Reservoir (CVP–1945); although this was not an expressed purpose of the project.

In 1959 the California Legislature authorized the California State Water project. In 1960 the electorate ratified this legislation enabling the start of advanced planning and construction of the State Water project (SWP). It has become a means of distributing the State's water resources between the supply areas of the north and the need areas south of the Delta, in concert with Federal and private water development.

Presently, the average annual runoff to the Central Valley floor is about 30 million acre-feet. Diversions, primarily for irrigation, reduce this flow so only approximately 18 million acre-feet reach the Delta. About 1.5 million acre-feet are required for consumption in the Delta and about 12.5 million are estimated to be the future requirement for export from the Delta by the CVP and SWP. Increased requirements for water exported from the Delta and increased need to meet water quality standards contained in export water supply contracts will exceed the supply capability of the present cross-Delta conveyancy about 1980.

Use of the Delta

In its present manmade state, the Delta supports about 570,000 acres of agriculture; about 5 million days of recreational use per year (about 60,000 boats are registered for the area); more than 3.5 million days of fishing per year; an annual ocean commercial salmon catch of about 6 million pounds; a commercial shad catch of almost 1.5 million pounds; and a cross-Delta water transfer of about 2 million acre-feet per year.

In contrast to these benefits, the Delta is faced with a myriad of present and future problems, some of which may be summarized as follows:

1. Maintenance costs of the essentially privately-owned levee systems are steadily mounting due to land area subsidence (about 0.1 foot per year) and wave erosion caused by pleasure and commercial boating in the waterways.
2. Competition from other areas for high-valu produce crop markets and for available labo is forcing the Delta to use lower cost mechanized types of farming.
3. Waste discharge into the waterways from farming operations, municipal waste treatment plants, and ships and recreation boat is creating water pollution problems.
4. Increased commercial shipping is creating demand to deepen the Stockton and Sacramento Ship Channels which would plac added stress on the levee systems and possibl on the marine environment.
5. Increases in export pumping cause problem with anadromous fish spawning and possibl with the fish food supply.
6. CVP and SWP officials are negotiating wit Delta interests trying to collect payments t guarantee a year-round supply of qualit water to Delta water users.
7. Adoption of water quality standards, whil assuring quality water in the wasteway creates problems in maintaining the fragil levee system and in disposing of wastes from the land areas.
8. Special interest groups compete to have area of the Delta zoned exclusively for municipa development, for recreational development for fish and wildlife enhancement, or fo maintaining the Delta in its "natural" stat
9. Facilities are needed to accommodate steadily increasing recreational use of th Delta. (Some natives of the area say there ar already too many boats and recreationists i the Delta.)

Solutions to the Problems

Numerous solutions to these problems have bee proposed and each has been met by a steady strea of invective rhetoric demanding that the Delta b preserved in its "natural" state. To discuss al motives behind the passionate pleas would fill vol umes, however, several facts surrounding th situation are obvious.

The Delta is not in its natural state and has no been for over 100 years. The economic and socia impact of returning the Delta to its natural stat would be unacceptable to today's generation.

Many of the Delta's plants are hybrid varieties Its animals are selectively bred and nourished fo designated purposes; a large number of its fis

'op, Delta floods have "reclaimed" another section of the levee.
Center, Delta levee failure—a continuing vigilance for these workers.
Bottom, Sandbags have rescued this levee from complete destruction.

and wildlife resource species were imported from other areas and are carefully managed to meet a constantly increasing public demand; its levee systems must be regularly maintained; its land areas are constantly sinking; the flow and quality of waters in its streams are controlled much of each year by the works and actions of man; and increasing population in areas south and west of the Delta is placing greater demands on water supplies north and east of the Delta. The Delta is, therefore, a manmade, managed, or more descriptively, a *contrived and transient* environment.

The only real solution to saving the Delta is to manage it. Since all special interests cannot be satisfied, the best possible alternative would be to manage the Delta for maximum benefit of the greatest number of people.

Solutions Progress

Numerous plans and studies directed toward solving Delta problems are in various stages of progress. Among these are:

1. The proposed joint Federal-State Peripheral Canal would convey export waters around the eastern periphery of the Delta while at various points distributing flow to the interior Delta for consumption. It would remove the impact of cross-Delta water transfer on the Delta fishery.
2. Water quality standards have been adopted for protection of water users in the Delta.
3. Water rights diversion permitting conditions to extend water quality controls to the extreme western Delta and upper Suisun Bay are currently undergoing court tests.
4. Restrictions on municipal and industrial waste discharges, and commercial and pleasure boat discharges are being enforced.
5. Proposals to fill Delta island areas with organic wastes from the Bay area cities and with dredging spills from maintenance of the Stockton and Sacramento Ship Channels are being investigated.
6. Studies of recreational development and of zoning needs for future development of the Delta are being conducted by local, State, and Federal agencies.
7. Future waste disposal needs of the San Francisco Bay-Delta area are being studied.
8. Studies required for future management of the Delta fishery and waterfowl habitat main-

tenance in the Suisun Marsh on the western edge of the Delta are in progress.

9. Studies of need and design of future improvements to the Sacramento and Stockton Ship Channels are in progress.

The Delta has been used for many decades to meet the needs of man. These uses and the ravages of nature have created problems which are of critical importance today. With proper management, based on vastly enlarged data provided by the aforementioned studies and plans, as well as other studies, present and future, the Delta will continue to be a storehouse of benefits for California and for the Nation. # # #

NEWS NOTES

B. P. Bellport Retires

B. P. Bellport, who has headed the Bureau of Reclamation's design and construction activities since 1963, retired March 31, 1972, concluding a 35-year professional career with the Bureau.

Harold G. Arthur, presently deputy director of the Division of Design and Construction, has been designated acting chief of the division.

Reclamation Art Exhibition

A selection of paintings, watercolors and drawings chosen from more than 300 pictures in the Bureau of Reclamation's art program went on view March 25, 1972, at the National Gallery of Art.

Beginning in the fall, "The American Artist and Water Reclamation," as the exhibit is called, will be circulated throughout the country under the auspices of the Smithsonian Institution Traveling Exhibition Service.

A 27-minute color motion picture, dealing with Reclamation's effects on the environment, as seen through the eyes of the artists participating in the art program, premiered in the National Gallery on the opening day of the exhibit.

John DeWitt, developer and director of the Bureau's art program, received the Department of the Interior's Award for Meritorious Service.

Leon W. Hill Retires

Leon W. Hill, director of Region 5 of the Bureau of Reclamation since July 1959, retired April 29, 1972, after more than 36 years of Federal Government service. Region 5 with headquarters in Amarillo, Tex., encompasses all of Texas and Oklahoma, most of New Mexico, and portions of Kansas and Colorado.

James A. Bradley, chief of the Bureau's Division of Power in Washington, D.C., since 1970, succeeded Mr. Hill.

Bradley began his 24-year career with the Bureau in 1948 as an electrical engineer in the South Platte River District office in Estes Park, Colo. He spent 12 years in Region 5 and 2 years in Region 6 before coming to Washington.

Reclamation Assists Minority Contractors

Reclamation joined with the Small Business Administration to award a $47,000 contract to a minority construction firm for work in the Central Valley project in California.

Under the contract awarded, the R. D. Ramirez Construction Co., South San Francisco, Calif., will remove loose rock and boulders from the tailrace channel below Folsom Dam on the American River in the Central Valley project.

New Hoover Dam Facilities

New facilities at famous Hoover Dam have increased the visitor-handling capacity by a third. They were completed ahead of this year's peak tourist season, which began Memorial Day weekend.

The new facilities include an improved access tunnel in the Nevada wall of Black Canyon and a new platform over the lower penstock, deep in the canyon wall, through which water flows to the giant turbines in the Hoover hydroplant.

With the 1972 trek running well ahead of last year's, the 15 millionth visitor will take the guided tour in October while approximately 90 million will have visited the Lake Mead National Recreational area which extends from the head of Lake Mead to Davis Dam, downstream from Hoover Dam. # # #

Answers to Water Quiz

1. d; 2. c; 3. a; 4. These stairs became superfluous upon the completion of Shasta Dam. Prior to its construction, Sacramento River frequently overflowed and flooded the city, requiring the high stairs; 5. b, c, a, d.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972 O—464-477

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has carried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form may be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

FOR USE OF SUPT. DOCS.

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

Enclosed find $______________ (check, money order, or Documents coupons). Please enter my subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents per single copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code_____________________________

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-6913	Pick-Sloam Missouri Basin program	May 5	Environmental study, Upper South Platte unit, Mount Evans Division.	International Engineering Co., Inc. San Francisco, Calif.	$200,000
DC-6944	Pick-Sloan Missouri Basin program	May 12	Additions to Stegall substation	Addison Construction Co., Denver, Colo.	192,727
DS-6946	Columbia Basin	Apr. 28	Design of Grand Coulee Visitor Arrival Center.	Marcel Breuer & Associates, New York, N.Y.	165,471
		Contract date			
DR-12-21	Atmospheric Water Resources Management program.	Apr. 20	Comprehensive evaluation of cloud seeding results.	Aeromatic Research, Inc., Goleta, Calif.	259,308
00C-1195	Columbia Basin, Washington	Apr. 4	D85-22, -23A, -24, -31, -82, and -84 drain systems, block 85.	John M. Keltch, Inc., Pasco, Wash.	221,025
00C-1197	do	May 1	Drains and D16-37 pumping plant, block 16, schedules Nos. 1 and 1A.	do	323,640
00C-1203	do	May 23	Buried pipe drains, block 87, schedules Nos. 1 and 1B.	Roy Johnson Construction Co., Inc., Ephrata, Wash.	226,907
00C-498	Colorado River storage project	May 5	Water filtration plant addition, Glen Canyon unit.	E. Arthur Higgins, Centerville, Utah.	504,470
04C-88	Pick-Sloan Missouri Basin program, Helena-Great Falls Division.	Apr. 7	Westside dike	Empire Sand & Gravel Co., Inc., Billings, Mont.	387,300
04C-89	Pick-Sloan Missouri Basin program, Three Forks Division.	May 11	Earthwork and structures for pipe drains, berm construction, and modification of channels, fiscal year 1972.	Clark Bros. Contractors, Victor, Mont.	107,647

UNITED STATES
GOVERNMENT PRINTING OFFICE
PUBLIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

The Environment:
A RECLAMATION PRIORITY!

"It is the continuing policy of the Government . . . to create and maintain conditions under which man and nature can exist in harmonious balance . . ."—National Environmental Policy Act of 1969.

This is the goal which the Bureau of Reclamation has established to be of great importance. Charged by Congress with the responsibility to develop the water resources of the 17 Western States, the Bureau has had a tremendous opportunity to fulfill this goal.

Read in this informative pamphlet, how Reclamation has fulfilled its goal of maintaining a balanced and harmonious environment through flood control, fish and wildlife preservation, recreation development, new technology, environmental economics and irrigation improvements.

Write for your free copy today! Write to: Bureau of Reclamation, Attention Code 910, 18th & E Sts., N.W. Washington, D.C. 20240.

MAIL ORDER FORM to:

BUREAU OF RECLAMATION
Attention Code 910
18th & E Sts. N.W.
Washington, D.C. 20240

Dear Sirs:

Please send me ______ free copies of "The Environment: **A Reclamation Priority!**"

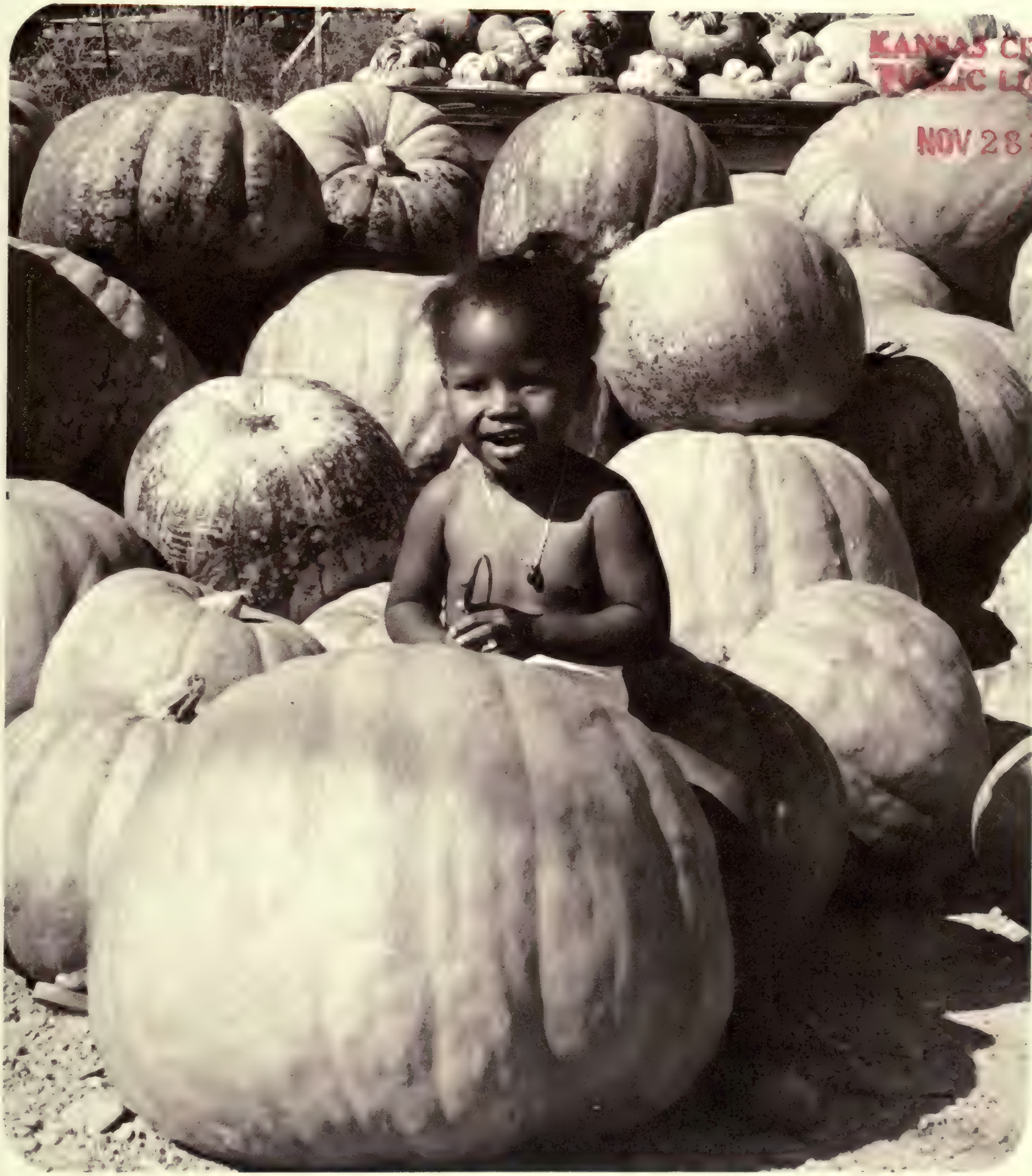
NAME ______________________________

STREET ADDRESS ______________________________

November 1972

RECLAMATION era

A WATER REVIEW QUARTERLY



November 1972 • Vol. 58, No. 4

RECLAMATION era

CONTENTS

COVER. This young lady, perched atop a pumpkin outweighing her by 100 pounds, knows that fall, especially Halloween time, wouldn't be the same without the bright orange fruit.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington, D.C. 20240. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 14, 1969.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 45 cents (single copy). Subscription price: $1.50 per year (50 cents additional for foreign mailing).

COMMISSIONER'S PAGE

Water—Our Horn of Plenty

Fall has traditionally been the time to apprecia the horn of plenty; with the increasing scarcity of our mo precious natural resource—water, today we not only a preciate the cornucopia, but the water that made availab the food that fills it.

As in the past, we are faced with the problem of ho best to use water. The cornerstone of western water law appropriation by right of beneficial use—was laid dow more than a century ago by Brigham Young when he to his followers in the pioneer settlement of Salt Lake Vall that no man should take more water than he needs to ma productive the land on which he and his family live.

This was a sharp contrast to the long-establish belief held by some landowners that every riparian had right to the water flowing past his doorstep to do with he chose.

The latter theory was based on the assumption th there was plenty of water for everyone and that rive would be useful as they continued to flow into the se regardless of how the water was used enroute.

Changing circumstances, particularly the pressur of a growing population and an advancing civilizatio have demonstrated that neither concept is totally adequa to meet today's needs, much less those of the future. Neve theless, they are the cornerstones upon which we can a must build if we are to fulfill our responsibilities to futu generations.

There must be adaptations. There must be flexibili in management to meet competitive needs. Above all, the must be responsibility to protect and use the availab water supplies in the most efficient manner possible to fu fill all requirements. This refers not only to water need for municipal, industrial and irrigation uses, but for fi and wildlife uses as well.

As we can see, the responsibility to achieve th falls upon the shoulders of all water users. If we are al to use water in the most efficient manner possible, we w insure that America's cornucopia will always be full.

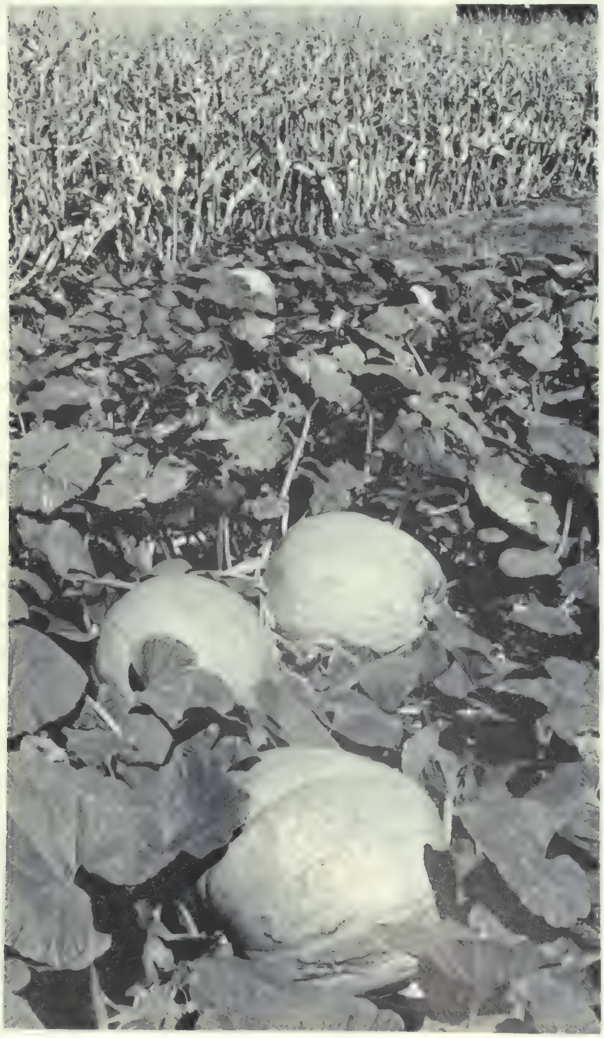
Ellis L. Armstrong

ELLIS L. ARMSTRONG
Commissioner of Reclam

Trick-or-Treat and Reclamation

This farm owner unsuccessfully tries to lift a huge pumpkin weighing over 100 pounds.

Top: Grown in the San Joaquin Valley, this Turbine Squash, despite its unique shape, is sometimes confused with pumpkin. *Bottom:* These pumpkins weighing only 35 pounds each, are grown on several Bureau of Reclamation projects, including the Central Valley project and the Solano project, Calif.



FEW people associate trick-or-treating with the Bureau of Reclamation, that is until they realize that Halloween would not be Halloween without pumpkins and pumpkins could not survive without water—often Bureau of Reclamation-supplied water.

Orginating in tropical America, several varieties of pumpkins were known to the Indians at the time of our early colonization. Today they are grown in nearly all parts of the United States, since their low nutrient requirement enables them to grow in well-limed and well-drained soils throughout the temperate zone.

Inconsistently referred to as pumpkins and as squash, the quick-growing, small-fruited bush or nontrailing varieties are called squash in America, while the long-season, long-trailing, large-fruited varieties are called pumpkins. The very largest varieties of pumpkin are more properly designated Winter Squash and may weigh 100 pounds or more. Other varieties are Sweet Cheese, Japanese Pie, Kentucky Field, Green Striped, to name only a few.

Turbine Squash, sometimes confused with certain varieties of pumpkin, is also shown here. So named because of its appearance, this vegetable is just one of the many agricultural products grown in west San Joaquin Valley. Irrigation water for the farmers in this area is supplied by the San Luis Unit, built by the Bureau.

These pumpkins, grown on the Bureau's Central Valley project, Calif., are stacked and ready for sale on a roadside market near Turlock, Calif. This area is part of the more than a million acres of fertile land receiving water from the project and producing annually more than $300 million worth of crops.

Fairly rich in carbohydrates and minerals, especially phosphorus, calcium and iron, pumpkins are raised between hills of corn or in fields by themselves in hills 8 to 10 feet apart. The American mammoth varieties are used for exhibition and stock feed while field and sugar pumpkins are used for pies and canning.

Other uses for pumpkins and squash include oil recovery from the vegetables' seeds and also a nutlike delicacy made by roasting and salting seed kernels.

Whether decorating a window with a lighted jack-o'-lantern or sampling a freshly baked pumpkin pie, each of us has enjoyed another agricultural product made possible by Bureau of Reclamation water. # # #

by LILLIAN TANGEN, Former Writer-Editor,
Johnny Horizon,
Washington, D.C.

Johnny Horizon

"Johnny Horizon, where do you go from here?
I'm on my way to a better day
Where the air is clean and the water is clear.
Johnny Horizon, may we come along with you?
If you come along, it's more than a song—
We've got a lot of work to do."

"Johnny Horizon" words and music
by Randy Sparks (ASCAP)

THE Johnny Horizon program celebrated its fourth birthday in July and it's fair to say "a lot of work" has already been accomplished by Johnny's many partners.

As a positive environmental action program, the Johnny Horizon program depends upon direct citizen involvement. Since its birth in 1968, it has involved thousands of volunteers in every state of the Nation, as well as in American Samoa. This year alone, requests for information have come from such distant points as Australia, Nigeria, and the Netherlands.

Johnny Horizon '76

Johnny's reception has been so successful that this fall the program was expanded to launch a campaign entitled "Johnny Horizon '76." With the message, "Let's clean up America for our 200th birthday," the campaign aims at uniting government at all levels, business and industry, and pri-

vate citizens in an effort to restore the natural beauty of our land by 1976—an accomplishment which certainly would give added meaning to our Bicentennial celebrations. Clean-up projects are encouraged by the Johnny Horizon programs in major urban centers across the Nation.

New program materials—many in patriotic red, white and blue—include a number of interesting tidbits for urban dwellers: booklets on rat control and recycling centers, information sheets containing eco-tips that concerned individuals of all age groups can follow to fight pollution and to develop environmental awareness.

Johnny represents to his supporters the thoughtful user of the environment. He is a volunteer. He wears no badge or uniform and enforces no law. He is a man of the land who is concerned with preserving the scenic beauty of America and with the dangers to public health and safety created by careless pollution.

He is concerned also with the heedless waste of our natural resources. In short, he speaks to the best in all of us. As the impact of the program increases each year, Johnny Horizon is fast becoming for pollution what Smokey Bear is for forest fires.

Johnny Horizon and the Bureau

Johnny and the Bureau of Reclamation have worked hand-in-hand on several projects to protect and to cleanse our environment.

In many of the Bureau's regions, old and young alike have pitched in to help remove litter along highways, garbage from fields and rural areas, and trash from recreation spots. Even scuba divers have taken part to clear rubble from streams and lakes.

Boy and Cub Scouts from New Mexico did their part during a cleanup campaign last spring by loading trash onto trucks. The land around the Navajo Indian Irrigation project (in the Bureau's Upper Colorado Region, but responsible to the

Boy Scouts from Troop 322 and Cub Scouts from Pack 322, Farmington, N.M. load trash into trucks during a cleanup campaign.

Top: Scuba divers played an important part in the cleanup project in American River, Calif.

Center and Bottom: Boy Scouts and 4–H Club girls from Boulder City assist Bureau of Reclamation employees from the Lower Colorado Regional office in Nevada.

Southwest Region) has been enhanced by their efforts.

Over 200 scuba divers made fine catches in the American River, below Nimbus Dam, on the Central Valley project, Calif. However, their catches were not pike, bass, bluegill or trout. Instead, they were rusty beer cans, rotted tires, strips of metal, and an old hub cap or two.

Other boosters of the Johnny Horizon program are Bureau of Reclamation employees of the Regional Office in Boulder City, Nev. They, with the help of 4–H Club girls and Boy Scouts, spent 120 hours removing 11 pick-up truckloads of litter near Boulder City and the Lake Mead National Recreation Area.

Johnny Horizon's Beginning

The program was launched officially by the Bureau of Land Management (BLM) in June

Before: Vista Site on old Highway 40 at Donner Summit, Nev. is bordered by defaced rock—as it looked prior to the invasion of over 400 Boy Scouts from the Tahoe Area Council.

During: These boys, as part of the Department of Interior's Johnny Horizon cleanup campaign, spent many hours grouting the rock. *After:* Presto! The eyesore is gone.

Headed by Burl Ives, many members of the entertainment industry have given their time and talent to promote the Johnny Horizon program.

1968 to create public awareness of a problem BLM had been facing for over 10 years—the increasing pollution of public lands by careless littering and vandalism.

In 1967 the estimated costs of a one-time cleanup campaign were staggering, and BLM recognized that such a project wouldn't be a satisfactory long-term solution to the situation.

A program was needed that would "turn on" the public, a program that would inform people of the pollution problem and involve them in doing something about it. It would be a do-it-yourself environmental program in which individuals or groups might participate.

The program was the first effort by the Federal Government to involve citizens in a way that President Nixon stressed in his first environmental message when he asked for "millions of helping hands."

Johnny began as a Westerner, because BLM lands are located primarily in the West. He looked like a typical outdoorsman—broad-brimmed hat and all. His reception and effectiveness in the West were so great the Tennessee Valley Authority, U.S. Army Corps of Engineers, and the U.S. Postal Service soon gave their support to the program.

Congress even passed legislation protecting the use of the name and symbol and authorizing the Department of the Interior to license the use of Johnny Horizon for commercial purposes. Royalties from these licenses are reserved for the program and allow Johnny to function on fewer tax dollars. A Licensing Committee was established to screen applicants to insure that products bearing the program's name and symbol maintain its goals.

Licensed Products

Among the licensed products, one of the most exciting is a kit for testing water and air pollution. It is produced by Parker Brothers, producers of the game, "Monopoly." The kit promote environmental education.

With the help of the Johnny Horizon Classroom Kit, school children and youth groups participate in projects which increase their awareness of the environment and stimulate involvement in sound environmental action. Educational materials prepared in cooperation with the U.S. Office of Education have been furnished to over 100,000 classrooms across the Nation. The teacher's material contains instructions which aid the

teacher in integrating environmental studies into the total curriculum.

The action arm of the program involves thousands of volunteers in environmental improvement and cleanup campaigns each year, such as those sponsored and organized by the Bureau of Reclamation.

Otherwise, to attain the results of these efforts would have cost millions of dollars if undertaken by local, State, or Federal governments. Of greater importance, however, is that they have involved millions of citizens in doing something positive about pollution—of caring for their own earth household.

Sponsors of these campaigns have ranged from hobby and scouting groups to school systems and chambers of commerce. Commercial cosponsors are encouraged to share production and distribution costs of promotional materials and litter bags.

Celebrities Help, Too!

Members of the entertainment industry, headed by Burl Ives, have rallied to help promote the Johnny Horizon program through personal appearances, records, and radio and TV public service announcements.

Celebrities who have participated include Sonny and Cher, Dinah Shore, Carol Burnett, Johnny Cash, Glen Campbell, Henry Gibson, Ed McMahon, Randy Sparks and the Back Porch Majority, Karen Blackwell, Eddy Arnold, Shari Lewis, Ed Ames, Joe Campanella, and Adam West. Johnny's newest partner, Snoopy—star of Charles Shultz's comic strip, "Peanuts"—daily attracts new supporters to the program.

Departmentwide

In July of this year, the Johnny Horizon program gained stature when its administration was transferred from the Bureau of Land Management to the Office of the Secretary. Plans for use of the program by all Departmental bureaus, as the Bureau of Reclamation has done, are now being developed.

Success has not gone to Johnny's head, nor has expansion caused him to lose sight of his goal first voiced in 1968. He is as sincere as ever in saying, "This land is your land—keep it clean."

With increasing program support, it is possible to believe the "better day" described in Johnny's song may be somewhere just around the corner.

# # #

The East Bench Environment

by HAROLD E. ALDRICH,
Regional Director, Bureau of Reclamation,
Billings, Mont.

LONG before the explosive impact created by the Environmental Protection Agency in 1969, construction on the East Bench Unit of the Pick-Sloan Missouri Basin had begun in 1961. At that time the Bureau of Reclamation was not required to prepare or file an environmental impact statement.

Even though the Bureau was not required to prepare a statement, it has been aware of the sometimes adverse factors connected with water resource development. But these factors are balanced or outweighed by adapting resources to the needs, aspirations and potentials of people which advance the interest of man and nature toward a productive total environment.

Sprinkler irrigation, now comprises 51 % of all irrigation on the East Bench Unit.

In planning and developing the East Bench Unit, the Bureau worked closely with agencies and local interests to protect and enhance the fishery, to provide recreation, to preserve historical sites, and to construct a project that fits in well with the total environment. Minimum flows and fish-excluding devices, for example, were included in project plans.

Old Reclamation Commercials

Although the "ecology movement" as we know it today was then beyond the wildest hopes of the most ardent conservationist, the challenge is great to listen to what someone has called "old Reclamation commercials." And so officials of the Upper Missouri Region decided to commission outside agencies to "tell it like it is."

Immediately following completion of Clark Canyon Dam in 1964, the Bureau contracted with the University of Montana to collect and analyze economic and historical information depicting conditions before project development.

The interim report was completed in 1967 when the U.S. Census of Agriculture for 1964 became available. A second analysis depicting conditions after project development is scheduled when the 1974 Census of Agriculture data are available.

The Bureau also contracted with the Montana Fish and Game Department for a fishery evaluation of Clark Canyon Reservoir and Beaverhead River, scheduled for completion in 1974.

But time, tide, as well as environmental and economic impacts, wait for no man. Consequently, an interim observation of the more obvious changes in the community since water first became available can provide a "sneak preview" of the disciplinarian's view and computer's linear and curvilinear relationships which will come later in the fulfillment of our contracts.

Early Need for Irrigation

Because the people of Beaverhead River Valley were aware of the need to solve their problems, and because they had the courage, persistence, and

enacity to do so, the water which otherwise would ot be used, benefited the entire valley.

The people of this region realized the need for rrigation shortly following the famed Lewis and Clark expedition which reached the valley in 1805. Nearly as long as the area's history of development vere its disputes, debates and legal actions over vater rights.

The first water right for irrigation of land in he Beaverhead River Valley was established in 865, and the diversion of water from the river or irrigation purposes developed rapidly. Dry arming was undertaken in earnest after passage f the Enlarged Homestead Act of 1909. Settlement was encouraged, but the low rainfall and hort growing season combined to discourage dryand farming operations.

ivestock Ranching

Livestock ranching became the predominant gricultural pursuit. Ranchers used all available vater resources for irrigation, occasionally diverting the entire flow of the river. However, without storage, little additional acreage could be irrigated adequately. The dryland area, predominantly the benchlands above the valley, were sparsely vegetated with native grasses and were used primarily for grazing.

Many water users in the valley and owners of the dry benchland were dissatisfied with the status of irrigation water supplies in the area and exerted considerable effort to alleviate the complicated water supply situation.

Several damsite drillings were made, but the engineering skills and money available were not adequate to complete the job. Eventually the erratic nature of unregulated streamflow, disputed water allotments, inability to follow long-range farm plans, and declining productivity resulting from inefficient irrigation practices combined to produce demands for positive actions leading toward a solution.

Water Problem Is Solved

In 1964, the water supply problem was finally solved by diplomatic trade-offs and sharing in

Fields of grain like this field of oats benefit from water from the Clark Canyon Dam.

Tim Winger carefully removes a lure from a large trout he landad at Barretts Diversion Dam on the Beaverhead River between Clark Canyon Dam and Dillon, Mont.

which the Bureau, the landowners, and community leaders cooperated. At that time, just a few months short of one hundred years since the filing of the first water right in Beaverhead Valley, the East Bench Unit of the Pick-Sloan Missouri Basin Program reached completion.

30-Mile-Long Unit

The unit in Beaverhead and Madison Counties, is approximately 30 miles long, from ½ to 7½ miles wide, and follows the northeastern course of Beaverhead River Valley and adjacent benchlands. The town of Dillon is within unit boundaries. Irrigation water storage is provided by Clark Canyon Dam, just below the junction of two streams—Red Rock River and Horse Prairie Creek—which join to form the Beaverhead River.

The East Bench development began as a part of the comprehensive, unified and multiobjective plan conceived to meet the special needs of the Missouri River Basin and, indirectly, the entire Nation. The objective of the Pick-Sloan Missouri Basin Program is to make the best and most efficient use of the water and related land resources of the Missouri Basin. This plan played a decisive role in the development of the East Bench Unit.

As It Looks Today

Clark Canyon Reservoir (Hap Hawkins Lake) first stored water in 1964. Since that time, it has prevented $1,255,000 in flood damages. Recreation visitation is increasing by leaps and bounds. An adequate flow has been maintained in all reaches of the river to sustain fish life, whereas prior to the construction of the dam, lack of water in several reaches of the river resulted in fish kills and limited fishing opportunities. The reservoir has annually furnished an adequate irrigation supply to the 21,800 acres of new lands and 28,000 acres of supplemental supply lands. Before the reservoir was completed, the supplemental supply lands often experienced severe shortages.

Flood Control

East Bench Unit flood control benefits are derived from the protection given municipalities of Beaverhead River's flood plain (primarily Dillon), rich farmlands and irrigation developments adjacent to the river, and roads and railroads that cross the river or flood plain. Although it was estimated that flood control benefits would be $123,000 annually, above-average runoff from the Beaverhead drainage basin resulted in the above-average total benefits of $1,255,000 reported by the Corps of Engineers for the 7-year period ending in 1971.

Installation of sprinkler irrigation systems, land leveling, and drainage speeded conversion from dryland to irrigation farming. The major impetus has been the introduction of sprinkler irrigation. By 1971, sprinkler systems served 49 percent of the lands.

An irrigation specialist, assisting the Bureau under contract with the Montana Cooperative Extension Service, also helped convert the East Bench Unit from dryland to irrigation farming.

During the early stages of development, the irrigation specialist provided farmers with information on modern irrigation practices; irrigation scheduling; improved varieties of grasses, alfalfa and grains; and established demonstration plots depicting effective water management and the value of proper fertilization.

Assistance was also provided to supplemental water users faced with the need to change from preproject irrigation practices based on a partial water supply to the conditions of a full season water supply controlled by releases from Clark Canyon Dam.

Prior to construction of the East Bench Unit, Beaverhead Valley had a small hay supply for winter feed. This shortage resulted in restricted herd sizes and less-than-optimum use of surrounding grazing lands. Because of the increased production and assured supply of alfalfa hay and feed barley, not only have the numbers of range livestock increased, but calf wintering and feedlot operations are more numerous, permitting more advantageous marketing.

Several new feedlots were constructed in 1968 and presently are in operation. Malting barley, an excellent cash crop, was marketed for the first time in 1968, with about 2,500 acres under contract in 1971. Irrigated pastures properly fertilized and watered have produced a reported 600 pounds of beef to the acre.

The following table shows acreage and crop production records between 1965–71, following completion of the project in 1965. Particularly interesting is the rapid development of new lands; 85 percent of the unit was producing within 3 years. These figures do not include livestock or livestock products. (Notice the great increase in total crop value in just six years.)

The Beaverhead public-use area is used by numerous visitors each year.

East Bench Unit—Pick-Sloan Missouri Basin Program (21,800 Irrigable Acres—Supplemental 28,004)

Year	Acres irrigated		Total crop value—Dollars	
	Full	Supplemental	Full	Supplemental
1965	8, 491	NA	279, 780	NA
1966	16, 307	27, 104	549, 651	1, 545, 249
1967	18, 750	27, 090	946, 765	1, 280, 708
1968	20, 274	27, 090	1, 005, 977	1, 097, 478
1969	20, 806	27, 090	1, 457, 453	1, 310, 420
1970	20, 941	27, 090	1, 512, 405	1, 602, 305
1971	21, 012	27, 090	1, 722, 372	1, 729, 428
			7, 474, 303	8, 565, 588

Recreational Areas

Two primary recreational areas exist in the East Bench Unit: Clark Canyon Reservoir and Barretts Diversion Dam. The diversion dam area is used by the public primarily as a fishing area, while at the reservoir, outdoor recreation enthusiasts enjoy picnicking, camping, swimming, fishing, boating, sightseeing, etc. To date only basic health and safety facilities have been provided for the public at both areas.

Visitation increased from 27,000 in 1965, the year the reservoir was filled, to 40,000 in 1971. With full development as anticipated under the Federal Water Project Recreation Act, it is expected that visitation will more than double in the foreseeable future.

Fishing Enhanced

Fishing has been excellent in Clark Canyon Reservoir and is outstanding downstream in the Beaverhead River. Sport fish in the area include rainbow and brown trout and mountain whitefish. Local sportsmen say fishing in the Beaverhead River, which was notable, has improved since completion of Clark Canyon Dam.

Prior to construction of Clark Canyon Dam, fishing was limited to the river upstream from Dillon, Mont., but fishing opportunities now extend approximately 30 river miles downstream from Dillon.

Sportsmen have attributed the development of this fishing to the storage of floodflows behind the dam thus maintaining minimum flows in all stretches of the river throughout the year, yet still meeting other project needs. Acknowledging both the bad and good, unavoidable high flows have occasionally interfered with fishing in the stretch between Clark Canyon and Barretts Diversion Dam.

Tom Wendelburg, author of an article on fishing in the Beaverhead in the January 1972 issue of *Field and Stream*, quotes Ron Marcoux, a Montana Fish and Game biologist,

> "It's hard for anglers to comprehend the great numbers of wild trout in the small Beaverhead. The river hasn't been stocked with browns since 1954 or with rainbows since 1960, but anglers at this time aren't even scratching the Beaverhead's trout population."

Total season take as indicated by reports of the Montana Department of Fish and Game have shown significant and steady increases in the Clark Canyon area since completion of the dam. In 1965 only 0.3 fish were caught per fisherman visit. This figure increased to 1.9 in 1968, 3.8 in 1970, and 5.3 in 1971. The number of fishermen visitations has more than doubled since 1965, while during the same period total annual sport fish catch increased by more than 37 times.

Fishery Rehabilitation Program

The original plan for East Bench Unit provided $140,000 for a fishery rehabilitation program, but later studies and experience showed this program would be unnecessary. Instead, much of the money is being used to help finance a 5-year fishery evaluation study being made by the Montana Fish and Game Department.

To learn more about the influence of dams on cold-water fisheries, both within reservoirs and in the rivers upstream and downstream, is the goal of this study. Interestingly, recent reports from the researchers performing this study indicate there are far greater numbers of trout in the Beaverhead River below the dam than had been anticipated.

Goose and duck hunters also enjoy use of the reservoir area. There were 450,000 duck use days and 15,000 geese use days at the reservoir in 1971.

And one final note—an industrial water supply contract providing a maximum of 175 acre-feet annually is making possible the operation of a mineral beneficiation plant which grinds talc for ceramic, paint and cosmetic industries and provides employment for about 56 full-time employees. # # #


NORTH DAKOTA GOOSE HUNTING
"geese on the horizon!"

Flocks of geese, out for early-morning feeding, are tempted by the unthrashed millet field below. A hunter in a pit blind soon discourages the flock, but not before two birds fall to the marksman.

This hunter calls to a flock of geese from an improvised blind on a rockpile near his decoys.

Young Scott Anderson seeks approval from hunting campanion Roger Master.

A successful hunt, no doubt about it!

Canada geese and ducks enjoy the protection of the Audubon National Wildlife Refuge.

"GEESE on the Horizon!" Each fall these words are echoed over and over again by an army of goose hunters huddled in their pits and blinds on the North Dakota prairies, waiting in the cold dawn for the first flight of geese.

Located on the Missouri Flyway, North Dakota's lush grain stubble fields and water areas attract hundreds of thousands of geese during their annual fall migration from Canadian nesting areas to their winter homes to the south. Blue, Snow and Canada geese are the predominant species, with other species in lesser numbers.

The State's goose population usually peaks in mid-October and continues through November or until the water areas freeze over or snow covers the stubble fields. During this period, hunters invade their favorite goose areas, filling hotels, motels, campgrounds and eating places—creating a carnival atmosphere in the small prairie towns.

The Bureau of Reclamation's Garrison Diversion Unit, now under construction, will straddle the prime goose areas in the State. Included as part of the unit, approximately 110,000 acres of migratory waterfowl areas will be acquired and developed with an assured and controlled water supply. Scattered throughout the unit, the waterfowl areas will be managed as public shooting areas by the U.S. Bureau of Sport Fisheries and Wildlife and the North Dakota Game and Fish Department.

With the number of hunters increasing each year and a decreasing land area available for public hunting, the waterfowl areas created by the Garrison Diversion Unit will provide new and badly needed hunting areas for the public. # #

Yesterday

in Our Magazine

THE RECLAMATION ERA—1950

Watch Hungry Horse Grow

by JACK CRISWELL
Chief Special Services Division,
Hungry Horse project, Mont.

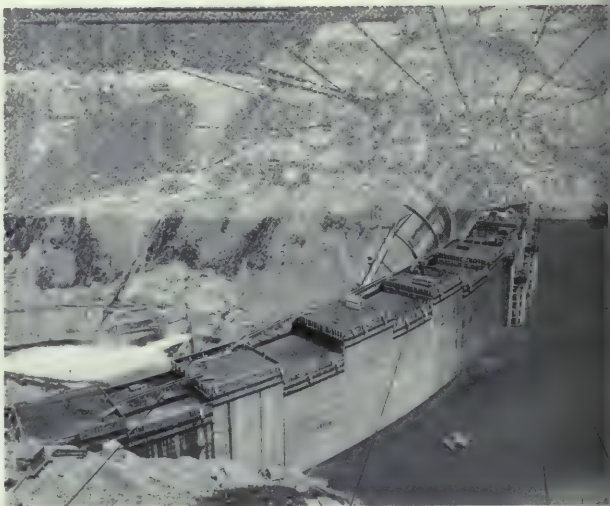
IN 1950, Hungry Horse begins to take shape. Construction of this big multiple-purpose Bureau of Reclamation project on the South Fork of the Flathead River in northwestern Montana, featuring the biggest concrete dam now being built in the world, has swung into high gear after the winter shut-down.

In the two construction seasons that have passed since the first construction blast reverberated between the steep canyon walls on July 10, 1948, General-Shea-Morrision, prime contractor, has completed the big job of excavating more than 1,000,000 cubic yards of earth and rock in preparing bedrock foundations for the dam and powerplant, and has erected one of the most efficient and up-to-date concrete production plants ever developed.

Climax of this first phase of the tremendous job of constructing the world's third highest (564 feet) and fourth largest (3,000,000 cubic yards) concrete dam came on September 7, 1949, when the first bucket of concrete was placed in the base of the dam. Racing against time, G-S-M placed a total of 59,554 cubic yards of concrete last fall before cold weather halted concrete operations for the winter.

When the dam is completed, it will back the waters of the South Fork into a 34-mile-long lake, 3½ miles wide at the widest point, with a storage capacity of 3,500,000 acre-feet.

By the time the Hungry Horse project is completed in November 1953, the mixing plant will have turned out enough concrete to build a 20-foot highway from Seattle to San Francisco and back—the equivalent of an 80-pound piece of concrete for every man, woman, and child in the United States.



Hungry Horse Dam, May 22, 1952: General view of the dam.

today...

EDITOR'S NOTE:

Last spring, rivers along the American-Canadian border were so full, they threatened a repeat of the 1948 flood which inundated Vancouver, Wash., and Portland, Oreg.

But, because of Hungry Horse Reservoir and grand Coulee Reservoir, floods were averted. Here is part of an account describing how Hungry Horse Reservoir prevented a disaster.

Drawdown at Hungry Horse Reservoir was necessary to avert floods.

HUNGRY HORSE NEWS—MAY 19, 1972

H. H. Dam Prevents Flooding this Week

by MEL RUDER,
Editor, Hungry Horse News,
Columbia Falls, Mont.

"WITHOUT Hungry Horse Dam, the Flat head River at Columbia Falls this week would have topped flood stage.

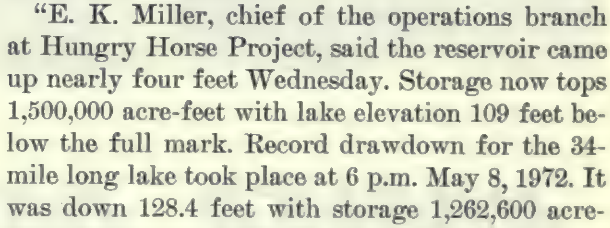
"Flathead River at Columbia Falls reached 12.2 on the gauge with a flow of 42,950 second-feet. Without Hungry Horse Dam, the river would have topped flood stage of 15 feet when the flow is 63,700 second-feet. Inflow at Hungry Horse Reservoir averaged 24,724 second-feet Wednesday.

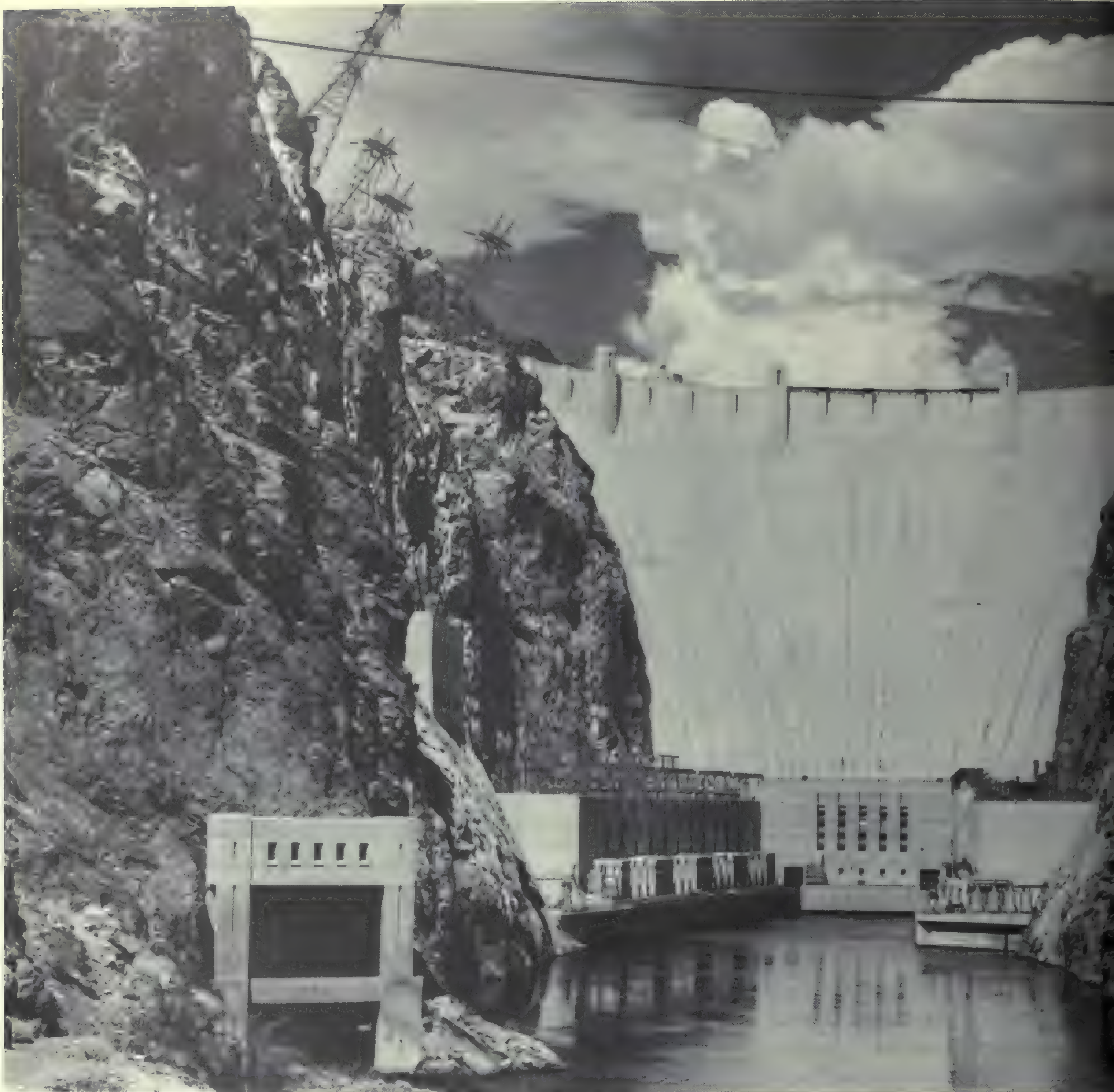
"Meteorologist Ray Hall at the U.S. Weather Service station, county airport, noted the Flathead River flow this week should be diminishing the flood threat. 'Similar flow for 10 or 12 days should bring down the water without a flood.'

"Monday reading at Columbia Falls was 10.4, Tue. 11.7, Wed. 12.2 and Thurs. noon, 12.1 feet with a flow of 42,300 cubic feet per second.

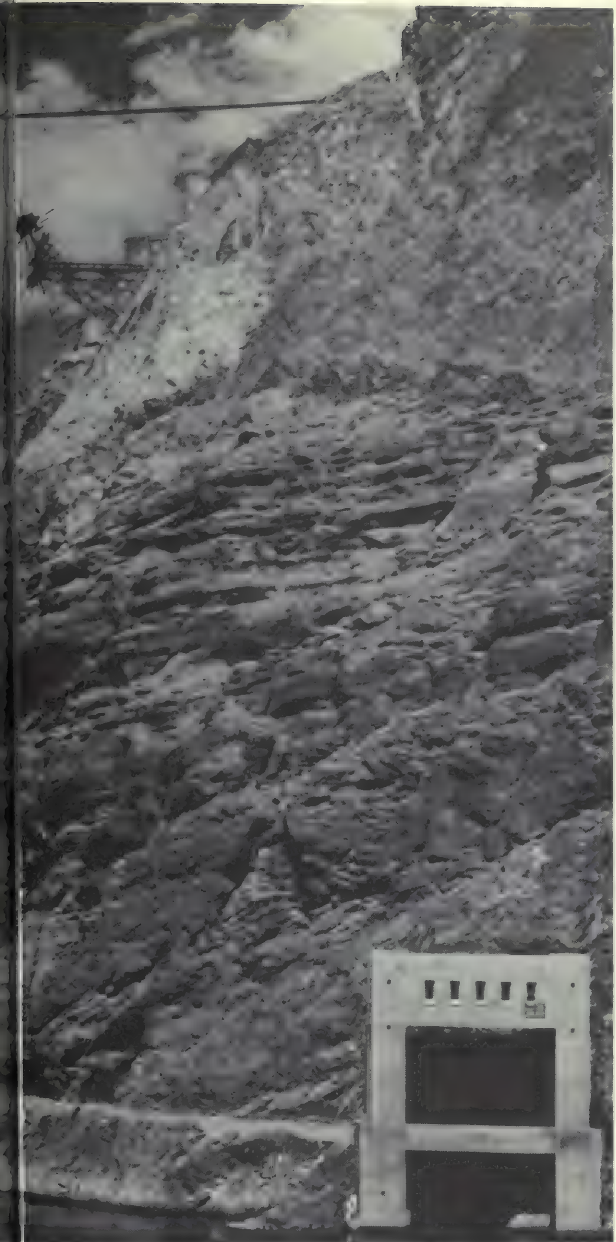
"Revised figures were received from the Weather Service river forecast center, Portland, Thurs. afternoon. Prediction is the Flathead at Columbia Falls will reach 11.9 Fri., 11.6 Sat., 11.1 Sun. and 10.7 Mon. . . .

"E. K. Miller, chief of the operations branch at Hungry Horse Project, said the reservoir came up nearly four feet Wednesday. Storage now tops 1,500,000 acre-feet with lake elevation 109 feet below the full mark. Record drawdown for the 34-mile long lake took place at 6 p.m. May 8, 1972. It was down 128.4 feet with storage 1,262,600 acre-feet compared to 3,468,000 when full. . . ."





HOOVER DAM, A Civil Defense Shelter!


Bureau of Reclamation's world-famous Hoover Dam on the Lower Colorado River could provide food and shelter for 9,000 people for two weeks in the event of a nuclear attack.

by MILDRED RHOADES,
Bureau of Reclamation Regional Safety Clerk,
Lower Colorado Region

HOOVER DAM, 30 miles from popular and populous Las Vegas, Nev., and visited by more than 600,000 people per year, has been designated as a fallout shelter and is one of the largest and most important shelters in Clark County.

Clark County has a population of over 300,000 and during a weekend this total is increased by an additional 70,000 tourists. In the event of a nuclear attack, Hoover Dam would be capable of accommodating approximately 9,000 persons, by providing them food and shelter for 2 weeks.

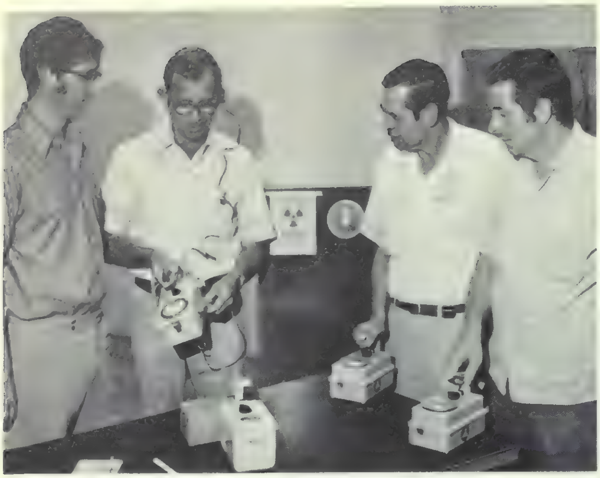
Civil Defense Organization

As a fallout shelter, Hoover Dam is part of the Clark County Civil Defense Organization. The Clark County Civil Defense Agency with headquarters at Arden, Nev., is organized to include Boulder City, Henderson, Las Vegas, and North Las Vegas.

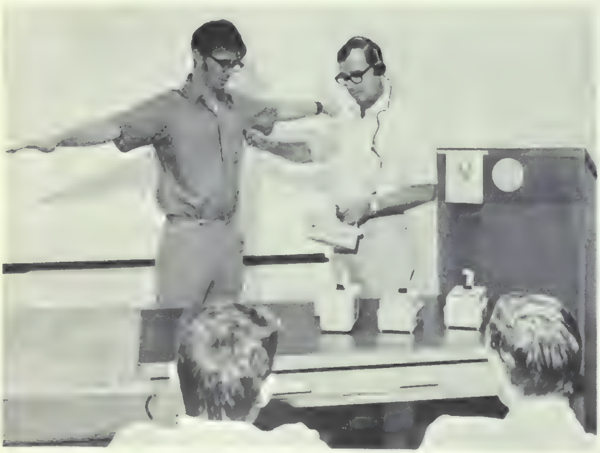
The Bureau of Reclamation provides civil defense instructors to teach radiological monitoring and shelter management. Included in the training are employees of the Lower Colorado Regional Office; Boulder Canyon project; National Park Service; Department of Water and Power, City of Los Angeles; Southern California Edison Co.; and the Bureau of Mines.

Refresher Course Offered

Basic and refresher courses in radiological monitoring and shelter management are conducted on



Above: **Radiological Monitor Instructor George Neibauer conducts a class in radiological monitoring.** ***Below:*** **A radioactivity-monitoring demonstration is presented for the trainees.**



a continuing basis at the dam for assigned personnel.

The training, conducted during working hours includes a 16-hour basic course and a 4-hour refresher course. Personnel are selected to insure that no office is deprived of too many individuals at any one time.

Radiological monitors are trained to measure radiation received in the event of fallout and thus assist in answering questions such as, "When will it be safe to leave the shelter and for how long?" George Niebauer of the Boulder Canyon project is the radiological monitor instructor.

Shelter Managers

Shelter managers are trained in the distribution and use of food, water, sanitation facilities and

Shelter Manager Instructor Donald Fisher checks survival supplies on the 9th floor of Hoover Dam which has been designated as a southern Nevada fallout shelter.

medical supplies available in the shelter. Shelter managers also learn how to cope with psychological problems that can occur in a shelter due to crowded conditions and the tension resulting from unusual living situations. Don Fisher of the Boulder Canyon project is the shelter manager instructor.

The civil defense training received by these individuals is not only available to the residents of the area in the event of a nuclear attack, but can be utilized for natural disasters such as earthquakes, floods, etc.

The Bureau of Reclamation coordinates its civil defense activities with the Clark County Civil Defense authorities. In so doing the Bureau will be able to accomplish a smooth transition from a civil defense emergency period to a period of rehabilitation and restoration subsequent to any emergency. # # #

WATER Quiz

] A *dirhem* is a weight equal to approximately 48 grams and is used in Persia, Morocco, Turkey, etc. Billions of dirhems of water are used annually in these countries. For each letter in the word, name a use of water (for example, e = ecological).

] Which of the following is *not* true of the ancient Roman civilization?

a. They were masters of irrigation and swamp drainage.
b. They build elaborate pumping systems.
c. Mosquito abatement was partly the reason for digging canals.

] Identify this object →

a. A test soil sample
b. A concrete molding
c. An engine valve

] The quantities of food available from the sea are almost unlimited. Food production from the sea can be increased to nearly 19 times that being produced today. Are these statements true or false?

If fossil fuels continue to be used principally for their energy contents, and if they continue to supply the bulk of the world's energy requirements the time required to exhaust the middle 80 percent of the resources of the petroleum family will be about a century. True or false?

Answers on page 29.

Prior to modern-day chemicals, removal of irrigation canal pondweeds was a laborous, manual job.

Restrictions on Pesticide Uses

FOR centuries man has sought to control weeds, insects and rodents. Now he is learning to control his controls.

Regulations concerning the use of pesticides are increasing. Because of this, operation and maintenance personnel on Reclamation projects are faced with increasing problems as they carry out their difficult task of controlling pests along canal systems, reservoir areas, power transmission lines and on other Government-owned lands.

Executive orders require full compliance with all State and Federal anti-pollution regulations at Federal facilities and on Federally-owned lands, including the restricted use of pesticides. The Secretary of the Interior has issued guidelines to implement Presidential directives for pollution control and environmental enhancement.

Must Approve Pesticide Proposals

Departmental policy includes the requirement that each Federal agency's proposals for pest control must be approved yearly, prior to their implementation. Approval must be given by the Federal Working Group on Pest Management, which is responsible to the Council on Environmental Quality.

The Working Group includes specialists in various fields of pest control. Agencies representing the group are the Departments of Defense; Interior; State; Agriculture; Commerce; Transportation; Health, Education, and Welfare; and the Environmental Protection Agency (EPA).

The Working Group has observers from the offices of Science and Technology, Management and Budget, Intergovernmental Relations, the Council on Environmental quality and the National Science Foundation.

One of Interior's representatives is an environmental specialist from the Commissioner of Reclamation's office. This representative serves on the Working Group's Program Review Panel which reviews all Federal pest control programs. The panel evaluates the effectiveness of the programs on the basis of their benefits and risks to man, wildlife and the environment. The panel then makes recommendations to Working Group.

by ROY H. BOYD, Chief, Water Operations Branch
Division of Water and Land
Bureau of Reclamation, Washington, D.C.

Prohibited List

Some old pesticide standbys, such as amitrol for control of Reed Canarygrass and cattails, and DDT for killing mosquitoes and flies, are now on the "Prohibited List." The chemicals on this list are not used in the pest control programs of Interior agencies because there is concern that they may have a detrimental effect on man or nontarget plants and animals.

Restricted List

Other pesticides, such as organic arsenical compounds for control of Johnsongrass, cyanide compounds and 1080 (sodium monofluoroacetate) for control of rodents and paraquat for use on wild oats and other annual weeds, are on a "Restricted List." These may be used only in special instances where target conditions and application methods are considered by the Working Group on Pest Management and approved by it, provided its use is also consistent with Departmental guidelines. The lists of both prohibited and restricted pesticides are subject to change. The current lists are shown in tables 1 and 2 respectively.

All pesticides (herbicides, insecticides and rodenticides) must be registered by EPA for specified purposes and conditions of use, as described on the container labels, before they may be shipped in interstate commerce. One of the following conditions must exist for registration to be allowed: (1) The residue is not harmful, (2) there is a negligible amount of residue, or (3) that a finite tolerance limit has been established. A tolerance is the determination of allowable pesticide residues in parts per million (p.p.m.) which can be contained in a crop, in animal tissue or product (i.e. chicken eggs, cow milk), or in water and not constitute a hazard to man, nontarget animals or plants.

TABLE 1.—*Prohibited List of Pesticides*

Aldrin	2,4,5-T
Amitrole	Dieldrin
Arsenical compounds (inorganic)	Endrin
Azodrin	Heptachlor
Bidrin	Mercurial compounds
DDT	Strobane
DDD (TDE)	Thallium Sulfate
	Toxaphene

TABLE 2.—*Restricted List of Pesticides*

Aramite	Endosulfan
Arsenical compounds (organic)	EPN
Azinphosmethyl (Guthion)	Ethion
Benzene hexachloride	Kepone
Carbophenothion (Trithion)	Lindane
Chlordane	Methyl Parathion
Coumaphos	Mevinphos (Phosdrin)
Cyanide compounds	Mirex
Demeton	Nicotine compounds
Diazinon	Paraquat
Dioxathion	Parathion
Diquat	Phorate (Thimet)
Disulfoton (Di-Syston)	Phosphamidon
DN compounds, such as Dinitrocresol	Picloram
Dursban	Sodium Monofluoroacetate (1080)
	Temik
	TEPP
	Zectran

Restricted Use Near Water

A number of pesticides have been registered for use on crops or land, but few are cleared for use under the aquatic conditions existing around canals and reservoirs. One reason is that manufacturing companies register pesticides in greatest demand and, by comparison, there is not a large market for pesticides for use in aquatic areas and the profits on their sales often are small. Considerable time and funds are needed for research to determine tolerances for pesticides.

Since private industry has been reluctant to register herbicides for aquatic weed control, some Federal agencies have been forced to enter the research field. Reclamation is presently working with the Agricultural Research Service (Department of Agriculture) and the Bureau of Sport Fisheries and Wildlife to obtain tolerance data on 2,4-D (2,4-Dichlorophenoxyacetic acid) and xylene for use in aquatic areas.

Elimination of certain effective pesticides will not necessarily cause a regression to the late 1940's when weed control was primarily a manual job of cutting and removing canal weeds.

In most cases, there are alternatives more acceptable to the environment, although they may be more expensive and less effective on the specific target.

There is a real need for newer and better pesticides that are safe to use. However, the time (6–10 years) and the expense (as high as $10 million) of developing new products, with no assurance they

Top: Numerous man-hours were required to remove these weeds along the irrigation lateral before chemical control methods were available.

Center: The application of aromatic solvent (xylene) into the canal prevents growth of aquatic weeds which restrict flow of water.

Bottom: Helicopters are often the most effective means of applying herbicides for vegetation control because they can be used along drains and other areas sometimes inaccessible to other spray equipment.

This mobile equipment with adjustable spray booms is used to apply herbicides on weeds along irrigation canals and drains.

will be acceptable to EPA, discourages many manufacturing companies from undertaking such work.

Restricted Use on Federal Lands

A recent example of pest control restrictions affecting a Reclamation project is Executive Order 11643, issued by the President on February 8, 1972. Concerned with mitigating damage to animals on Federal lands, this order forbids the use of any chemical toxicant for the purpose of killing predatory mammals or birds on Federal lands or the use of any chemical toxicant which will have a secondary poisoning effect. The latter includes the use of 1080 which may be fatal to carrion eaters (such as foxes, coyotes, or eagles) feeding on animals killed by this poison.

Guidelines to implement Executive Order 11643 were issued by the Department on May 23, 1972. The guidelines authorize use of zinc phosphide, strychnine alkaloid and certain fumigants for small mammal damage control under conditions which would preclude secondary poisoning effects.

When the order was issued, it was evident that conditions in parts of the Klamath project adjacent to the California-Oregon State border were conducive to a field mice population explosion. Although the expected eruption did not occur, the success of using second choice, zinc phosphide, was minimal compared to what would have happened if Compound 1080, the preferred chemical, had been used as in former years.

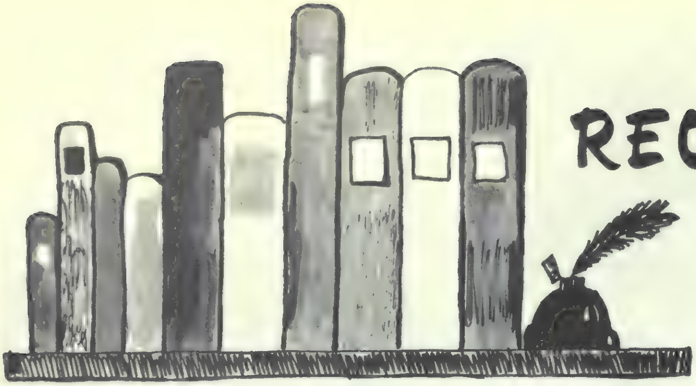
Compound 1080 was successful in controlling the mice on privately owned lands in the vicinity. Executive Order 11643 allows for exceptions only when it is necessary to: (1) protect human life, (2) protect an endangered species, or to (3) prevent serious damage to a nationally significant natural resource. Such exception could not be claimed for conditions on the Klamath project even though leaselands owned by the Federal Government were involved.

Research Is Needed

Great need exists for more research on pest control especially to establish tolerances for pesticides used under aquatic conditions. Also, more studies are required to compare, on both an economic and environmental basis, the benefits and disadvantages of pest damage control in specific situations.

We all favor pollution control. And there are situations where pests, such as weeds, become pollutants and are detrimental to an aesthetic environment and to the health and welfare of man. Mosquitoes and flies can become real health hazards and burrowing rodents can endanger canal structures and crops, hence they must be controlled.

The ideal pesticide would be cheap, safe and effective—and make both the producer and the environmentalist happy. Unfortunately, this doesn't exist in many situations of pest control; therefore, users and research scientists must continue to search for pesticides that will do the most good for all interests. # # #



RECLAMATION'S LIBRARY

EDITOR'S NOTE:

As part of our effort to keep *Reclamation Era* readers abreast of publications dealing with water resources conservation and development, we will be running this section, "Reclamation's Library" to inform you of what is available on the subject.

Any contributions to our library should list the publication title, cost, address from where it may be obtained and a short synopsis of the content. Send information to: Editor, *Reclamation Era*, Department of Interior, 18th and E Streets NW., Washington, D.C. 20240.

Thesaurus of Water Resource Terms. ($3.25) Published by the Bureau of Reclamation, this book contains more than 6,500 technical and scientific words.

The 339-page soft-cover volume measures 8 by 10½ inches, and is available at Government Printing Offices or by writing: Bureau of Reclamation, Engineering and Research Center, Attention: Code 922, Building 67, Denver Federal Center, Denver, Colo. 80225 (payment must accompany order).

These publications may be obtained from the U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver, Colo. 80225:

"Evaluation of Effect of Impoundment on Water Quality in Cheney Reservoir," Research Report No. 25, 1971 ($1).

Water quality of new plains-type reservoir, measured with physical, chemical, and biological data. Emphasis on salt balance and use of multiple outlets to control quality of water released to Wichita, Kans.

"Evaluation of Soil-applied Herbicides for Vegetation Control," Research Report No. 22, 1970 (0.45¢).

Wet and dry herbicides applied to weed control problems of irrigation and power operations, resulting in more efficient herbicides and reduced maintenance costs.

"Western U.S. Water Plan, 1971 Progress Report," (no charge).

A brochure explaining the 1968-authorized plan to study future water needs of the 11 Western States. To be culminated in 1977, the Westwide Study considers weather modification, water desalting, and reuse of waste water among the means of using and augmenting existing resources.

"Skywater," 1971 (no charge).

A brochure describing progress in precipitation management during the first decade of Bureau of Reclamation's cloud seeding research.

NEWS NOTES

Reclamation Adjusts Organization

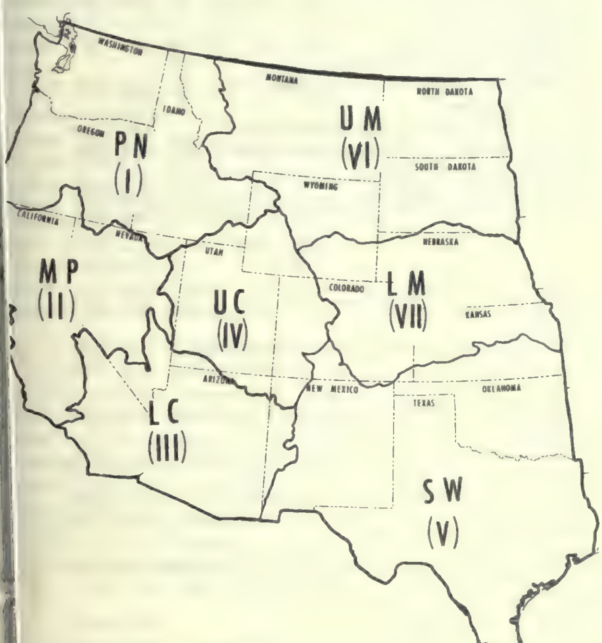
The Bureau has adjusted its organization to comply with the Federal standard regional boundary pattern. Present regional and field offices have been maintained and the impact on personnel has been minimal.

Secretary Morton directed all Department of the Interior bureaus and offices to establish common regional boundaries to conform as closely as practicable to the 10-region Federal organization President Nixon outlined in 1969. The objective is to facilitate interagency coordination.

The new organization takes into account that the Bureau's basic responsibilities are confined to the 17 Western States and its regions have been arranged along major drainage lines.

Physical boundaries of the regions and headquarters' locations remain the same. The Bureau no longer identifies its regions by seven numerical designations, but they are designated respectively: Pacific Northwest, Mid-Pacific, Lower Colorado, Upper Colorado, Southwest, Upper Missouri, and Lower Missouri (see map).

Coordination responsibilities in Federal Regions VI and X are assumed by the Reclamation Regional Directors located at Amarillo, Tex. and Boise, Idaho respectively. A Reclamation Regional Coordinator is to be stationed at Denver, Colo. to handle responsibilities for Federal Regions VII and VIII, while a Coordinator at Sacramento, Calif. will handle responsibilities for Federal Region IX.



U.S.S.R.-U.S. Technical Exchange Mission

A United States team concerned primarily with high voltage transmission of electricity returned August 5 from a 2-week exchange visit to the Union of Soviet Socialist Republics.

Commissioner Ellis L. Armstrong, chairman of the United States Committee of the World Energy Conference, said the group visited the central power dispatching centers in Moscow and eastern Siberia, where it viewed substations, transmission lines and the 800-kv direct current system emanating from Volgograd.

"These exchange visits are not only helpful in providing an exchange of technical information between the two nations, but also in furthering the cause of world peace through better understanding of mutual scientific and technological problems," the Commissioner reported.

TO OUR READERS

We would like to hear from you! If you have suggestions for articles you would like to see in the *Era*, if you would just like to air an opinion about the magazine, or perhaps you have an original cartoon dealing with water, send us a letter.

Send responses to: Editor, *Reclamation Era*, Department of Interior, 18th and E Streets NW., Washington, D.C. 20240.

Answers to Water Quiz

1. d=domestic, i=industrial, r=recreational, h=hydroelectric, m=municipal; 2. b; 3. a. This sample was under tension for approximately 28 hours before failure occurred; 4. False. Food from the sea is limited, we may get only 2.5 times that being produced now; 5. True (*Resources and Man*, Committee on Resources and Man, National Academy of Science—National Research Council).

INDEX TO RECLAMATION ERA

Volumes 56, 57, 58

1970–72

U.S. GOVERNMENT PRINTING OFFICE 1972 O—475-886

Convenient Order Form for *Reclamation Era*

In its 4 issues a year the *Reclamation Era* will bring the authoritative information that it has carried on its pages since 1905. If you are not now a subscriber, and would like to be, this order form may be clipped for your convenience.

To save frequent renewals, subscribe for 3 years.

MAIL ORDER FORM TO:

FOR USE OF SUPT. DOCS.	

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

Enclosed find $______________ (check, money order, or Documents coupons). Please enter my subscription to *RECLAMATION ERA* for one ☐, two ☐, or three ☐ years, at $1.50 a year; 45 cents per single copy; (50 cents additional for foreign mailing).

Name____

Address____

City, State, and ZIP Code____

UNITED STATES
ERNMENT PRINTING OFFICE
BLIC DOCUMENTS DEPARTMENT
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. GOVERNMENT PRINTING OFFICE

U.S.MAIL

IL **ORDER FORM** to:

BUREAU OF RECLAMATION
Attention Code 910
18th & E Sts. N.W.
Washington, D.C. 20240

Dear Sirs:

Please send me ______ free copies of "The Environment: A Reclamation Priority!"

NAME ____

STREET ADDRESS ____________________________________